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Science in Modern Living

FOREWORD

THE Bureau of Educational Research in Science was authorized by the Dean of Teachers College, and established in September, 1935, to initiate and carry forward studies in the teaching of science. It was made financially possible by a grant from the General Education Board and it has been assisted in its work by the cooperation of various public schools, colleges, and universities that have given leave to certain members of their staffs to work as research associates on phases of the project. The Bureau has been advised in its various activities by a committee appointed by the President of Columbia University from the Graduate Faculties of the University. Experts from the fields of science and from psychology, sociology, school administration, and education have met from time to time to counsel informally with members of the Bureau staff.

The background of the work of the Bureau was first stated in an article entitled "Educational Values of Science Teaching" in the *Teachers College Record* for October, 1930. It was further elaborated in "A Program for Teaching Science," Part I of *The Thirty-first Yearbook of the National Society for the Study of Education*, 1931. The preliminary statement of working plans was drawn up in a memorandum entitled "A Program for Science Education," dated April, 1934.

Interests of the Bureau have been centered in a program of science teaching designed to contribute to general education; that is, one in which content of the curriculum and methods of teaching are chosen

because of their significance for human living. These interests, therefore, carry us beyond the program of science teaching, for we cannot think of science in general education as something apart from other aspects of the curriculum. Tradition and preparation for college have dominated both content and methods in the curricula of the past. It is not contended that curricula so dominated are necessarily poor in whole or in part, especially when viewed from the point of view of the purposes for which they were designed; rather it is contended that curricula consciously planned to contribute to general education will better serve that end than those in which such a contribution, if present at all, is a by-product.

The two main divisions of the work of the Bureau are (1) curriculum study and (2) study of processes and outcomes in teaching and learning. The research associates primarily interested in curriculum have explored recorded knowledge in the scientific fields in which they, as individuals, are most competent and are issuing the results of their studies in a series of monographs. The research associates concerned with the study of processes and outcomes have prepared a series of suggestions for teaching called source units, with classroom procedures to help young people use significant materials from science in dealing with the situations and problems with which they must deal, as well as those which they seek out because of interests and aptitudes. The suggestions include plans for detailed study of the changes that occur in young people as they use what is judged to be significant material for dealing directly with these situations and problems. Extension of the work includes provision for study with teachers in cooperating schools under the supervision of a member of the Bureau staff and for a curriculum workshop in which these teachers may extend their study with attention chiefly on interpretation of results and further planning in the light of these results. The reports from these studies will be issued with the source units to which they are related as a series of pamphlets or small monographs. The work of the Bureau in both its divisions is described and illustrated in the accompanying articles.*

SAMUEL RALPH POWERS

*The monographs reporting the curriculum studies and the pamphlets and monographs reporting the studies of processes and outcomes will be published by the Teachers College Bureau of Publications.

Improvement of Science Teaching

By SAMUEL RALPH POWERS

PROFESSOR OF NATURAL SCIENCES AND EXECUTIVE OFFICER, BUREAU OF EDUCATIONAL RESEARCH IN SCIENCE, TEACHERS COLLEGE

UNTIL the last century the secondary schools were still primarily concerned with the education of the small minority of adolescents who were destined to occupy positions of privilege and influence in society and most of whom passed on to college. Today, though the schools are still concerned with the education of this minority, they are also concerned with the education of a much larger number of young people who will make up the majority of the coming generation of adults. But, in spite of these changes, there has never been any thoroughgoing examination of whether the form of education evolved for the education of a privileged minority in a pre-industrial society was appropriate even for the education of the corresponding minority in a society that was rapidly becoming transformed by the advance of industry. Still less has there been any thoroughgoing examination of whether the education evolved to meet the conditions of a society that was still largely feudal is appropriate for a modern democracy. Though scientifically planned studies have, to a large extent, replaced classical studies, and though practical activities of various kinds have been introduced into the curriculum, many of the assumptions underlying the older tradition continue to rule the practice of education.

Of recent years considerable attention has been given to the reform of secondary education, especially with regard to the problems of encouraging the development of personality and of preparing young people for more effective participation in democratic society. It is now generally recognized that the development of personality can take place effectively only under conditions where initiative and practical judgment are much more encouraged than they are under traditional forms of education. It is also generally recognized (though there are a few notable dis-

sentients) that for effective participation in democratic society, as well as for the improvement of that society itself, young people, including those who are to be specialists, should have a much wider knowledge and understanding of the world in which they are living and of its history than the traditional curriculum affords them.

To meet these changed conditions, educators are now concerned with the problem of devising a system of general education which will be appropriate to the conditions of the times, as well as to the ideals of American democracy. We have been especially concerned with the methods whereby the various subjects of the curriculum could be brought into closer relationship with one another, so as to contribute more effectively to young people's understanding of themselves and of the world. It seems clear that, in order to achieve this, the sharp dichotomy which at present exists between arts and sciences must be broken down so as to bring young people to understand how scientific methods can be applied to all questions of fact and how all forms of action are in some measure an expression of art.

CHANGING CONCEPTIONS OF THE FUNCTION OF SCIENCE TEACHING

As a part of this wider problem, we have been concerned in Teachers College with changing science teaching so as to make it contribute more effectively to general education.[1] With this specific question we have been able to make more definite progress through financial support given by the General Education Board. This has made possible enlistment of the services of a number of specialists representing different sciences who could give their whole time to making a cooperative study of the question. These science specialists have kept in close touch with one another so that the project is thoroughly cooperative. Just now we are issuing a number of reports which make specific suggestions as to how science teaching may be made more effective and we are following up our recommendations with empirical inquiries aimed at discovering how the recommendations work out in practice, and how they should be modified in the interests of general education.

In approaching their task the members of this science group decided

[1] Other groups of workers have been interested in this problem. See, for example, *Science in General Education*, Appleton-Century Co., New York, 1938.

first to ask what are the chief shortcomings in the common practice of science teaching. In their opinion these are many, even when science teaching is regarded only as a preparation of specialist workers in particular sciences. When regarded from the point of view of general education, the shortcomings are much more numerous. The main shortcomings of present science teaching, looked at from the point of view of specialist training, seem to be:

1. That there is far too little correlation between the different sciences.
2. That in all sciences there is emphasis on the abstract formulations of theory before sufficient practical experience has been gained in the situations to which theories refer.
3. That there is insufficient emphasis on the conditions which have to be fulfilled before valid scientific generalizations may be made (scientific caution, etc.).
4. That insufficient attention is given to the basic, methodological problems (e.g., problems of classification, of measurement, of defining concepts and units, of statistical problems, etc.).
5. That there is insufficient encouragement given young people in the practice of scientific methods through the pursuit of real problems.
6. That too little is done to bring children to appreciate the part that unambiguous formulation and communication of principles plays in science.

From the point of view of general education, there are further shortcomings to be remedied, of which perhaps the most important are:

1. That science teaching fails to give young people a sufficiently clear understanding of the physiology of their own bodies and the conditions of personal and social health.
2. That science teaching fails to give a coherent picture of the world as revealed by science.
3. That too little is done to bring young people to appreciate the applicability of scientific methods to practical problems of all kinds, including psychological and sociological problems.
4. That there is insufficient reference to the practical aspects of science, both with regard to its place in social history and with regard to the part it is playing in the transformation of the world.

5. That young people are not brought to recognize sufficiently clearly the way in which society is dependent upon natural resources and upon technology.

6. That young people are not brought to recognize the major problems confronting society in which science may help.

7. That too little is done to teach science so as to free young people from traditional feelings of fear and guilt, as well as from the influence of quackery, whether commercial, political, or religious.

A MORE LIBERAL CONCEPTION OF SCIENCE

To meet these criticisms, it is not only necessary that important changes should be made in the curriculum, it is also necessary that science teachers should themselves acquire a more liberal conception of science. The reports which are being prepared by the Bureau of Educational Research in Science, therefore, are addressed to science teachers, especially to those who are appointed to city and state committees responsible for drafting curricula, in an effort to help them modify their science curricula and teaching methods so as to contribute more effectively to general education. The reports will emphasize those facts and those relationships which are of the greatest importance to young people in building up a picture of the world in which they live, and in learning to enter into the manifold relationships of adult life. They will not only help to complete the general pattern of knowledge which the workers in the Bureau believe important to general education, but they will also suggest methods by which this pattern can be conveyed to young people so as to encourage in them scientific attitudes and practices. Each report will be accompanied by one or more "source units" making definite suggestions as to methods of teaching and evaluating.

The contents of the reports that are being prepared are suggested by the following outline:

I. The Structure and Development of the Physical Universe
   - *a.* The solar system and the cosmos
   - *b.* Atomic and molecular structure
   - *c.* The structure of the earth
   - *d.* Changes in the earth and the universe through the ages
   - *e.* Sources of energy—transformation of energy

II. Organization of the Living World and Its Changes Through Time
   a. Metabolism and growth
   b. Reproduction and genetics
   c. Behavior—the organism and its environment
   d. Evolution

III. Interrelation of Living Things
   a. Plant and animal ecology
   b. Relationships of plants and animals to man
   c. Human ecology

IV. The Control and Use of Energy and Materials Under Modern Conditions
   a. Sources, transformation, and utilization of energy
   b. Sources, transformation, and utilization of materials
   c. Organization of industry and its relation to the social structure
   d. The social functions of physical science

V. The Control and Use of Living Things Under Modern Conditions
   a. Sources and human food: agriculture and fisheries
   b. Plant and animal breeding and rearing
   c. Use of plant and animal products
   d. Social and economic relations involved

VI. Men's Thought About Themselves, About Society, and About the Universe
   a. Transition from magic to experimental science
   b. Scholasticism and formal logic in relation to experimentation and inductive thinking
   c. Science and language—the relation of theory to practice
   d. Relation of judgments of fact to judgments of value
   e. Science in its relation to art
   f. The relation of the sciences to one another—the difference in the problems they engage upon
   g. The relation of the history of science to social history

In the preparation of this basic material for general education and the accompanying suggestions for study of teaching and learning (issued as source units for teaching), we have been guided by certain assumptions that may be briefly reviewed.

TEACHING AND LEARNING

Human beings seek to achieve an intellectual command of behavior through an organization of knowledge and understanding that will serve

as a basis for socially satisfactory participation in the activities of modern living. General education contributes to this achievement. In our studies we are concerned primarily with what science has to contribute, but we are interested in the kind of learning that is consistent with the sum total of human knowledge and that leads to effective action in controlling and using our environment and making it what we want it to be. Obviously, there are other kinds of learning than that which results in intellectual command, and these include: conditioning, in the narrow sense; yielding to social pressure; and responding to emotions. These are not our first concern, but in any study of learning there must be recognition of them.

The activities of living are intimately interrelated, and learning is unitary, taking place as a whole; but for purposes of study these activities may be analyzed in various ways. As an approach to these analyses, it is convenient to recognize (1) the situations and problems with which the individual is likely to have to deal (or may choose to deal) in the course of his living in our society; and (2) the traits and capacities with which he must be equipped if he is to deal with these situations and problems in a manner which promotes the welfare of the individual and of the society of which he is a part.[2] The situations and problems contribute to the selection of curriculum materials. Traits and capacities contribute to the definition of qualities of personality. These, taken collectively, define the objectives of general education and hence the evaluative criteria.

The situations and problems may, for convenience, be classified as those arising out of:

1. Intimate personal contacts, particularly those of home and family.
2. Relationships with the economic system.
3. Relationships with the governmental system.
4. Relationship to instrumentalities of education, including the schools, the press, the radio, and the motion picture.

[2] This definition of situations and problems and of traits and capacities is the work of a Committee appointed by the Dean of Teachers College to consider a proposal for an enlarged program of work in the field of general education at Teachers College. The members of the Committee were Professors Karl W. Bigelow, Lennox Grey, Helen Judy-Bond, James L. Mursell, and Samuel Ralph Powers, Chairman.

5. The need to preserve physical and mental health in both personal and social aspects.

6. The need for recreation.

7. The conflict between the newer and older views of the nature of the world and of man.

The traits and capacities to be developed in individuals are those which will result in ability to deal effectively with situations and problems. In science teaching we are particularly concerned with these:

1. Specific information and specific skills. What immediate information and skills result from particular experiences? How well are these retained? Are they useful in everyday life? What are their relationships to thought processes, appreciations, value judgments, attitudes, and other personality qualities?

2. Generalized insights. What are the learner's concepts, for example, of the sun as a source of energy; of heredity; of the function of the family in our society; of functionality; of natural resources; of wealth; of intellectual integrity; of education?

3. Careful and critical methods of thinking. Under what conditions do children improve their ability to select data relevant to a problem; to evaluate their own conclusions; to hold suspended judgment? How are these related to teaching procedures, to mental maturity, and to out-of-school activities? Do these methods of thinking lead to creative activities and continuing interests?

4. Attitudes and appreciations. To what extent and under what conditions does the learner gain, for example, respect for objective evidence and for integrity in himself and in others; appreciation of needs and limitations of himself and others and of human variability; appreciation of the contributions of the major fields of knowledge and of the methods employed by workers in them?

5. An intelligent and workable philosophy for living in a modern world and in a democratic society. This is the most inclusive quality and leads us to inquire how effectively each young person integrates information and skills, generalizations, attitudes, interests, and ways of thinking into a unified and controlling way of life characterized by emotional orientation and control, and appropriate standards of value.

To what extent do young people develop curiosities, ethical tendencies, and social attitudes? Do young people grow in recognition of the part played in human life by intellectual, aesthetic, and ethical concerns? Do they gain in ability to recognize the limitations of hypotheses and theories, and to take account of the validity of data upon which conclusions are based? In these questions we are concerned with the extent to which our young people are building for themselves a world-view which is adequate to the changing society in which they live.

The foregoing brief discussion deals with the kinds of changes in students which may be stimulated by educational procedures as though the changes were separate entities. In fact, they are not distinct functions and the lines between them cannot be sharply drawn. We are anxious to avoid, as far as possible, an artificial and forced emphasis on one or another of these changes to the exclusion of the others. We would like to offer students opportunities for rich experiences and assist them to organize and integrate these experiences for themselves. We shall seek to study these experiences in teaching and learning so as to determine what generalized insights students will form, how they will modify their methods of thinking, what changes they will make in their behavior, what attitudes and appreciations they will develop, how they will modify their fundamental philosophy of life.

BROAD GENERALIZATIONS

The application of principles in teaching and learning may be made effectively through broad, interpretative generalizations (generalized insights) chosen on the basis of their ramifications into the interests and experiences of living. Illustrations are these:[3]

1. Human beings, like all other living things, live through a characteristic life span; abilities and traits as expressed at any one stage of development are the resultants of native endowment, rate of maturation, the experiences through which the individuals have passed, and their unique responses to those situations.[4]

[3] "Source Units" in which the educational implications of these and other generalizations, together with suggestions for teaching and for evaluation which are developed in detail, have been prepared for experimental use by the Bureau of Educational Research in Science.

[4] This is treated in the article by Anita D. Laton.

2. The progress of man has been accompanied by increased use of materials from the earth's crust.[5]

3. Human society is the immediate living environment of the individual human being and is interwoven with the general environment. Man, unlike other organisms, has the capacity to understand these relationships and thus the hope of controlling them.[6]

4. Human ideas concerning the nature of the physical universe are being continually evolved and refined through application of the methods that we call scientific.[7]

5. Biological production and control are increasingly important in contemporary life.[8]

6. Scientific methods have shown themselves capable of contributing to the solutions of an ever-widening range of problems. These methods, if suitably adapted, can contribute to the solution of problems of all kinds, including personal and community problems.[9]

7. Through generation after generation living things tend to resemble their parents and yet to differ from them.[10]

8. In all living things there is a selective and balanced exchange of materials (and energy) with the external world.[11]

There is space for brief analysis of but one of these generalizations.

AN ILLUSTRATION

We may recognize the bearing of the seventh, for example, on such questions as race prejudice and genetic differences between races, genetic and environmental influences on personality, and plant and animal breed-

[5] This is treated in the article by C. C. Furnas. Irving A. Cowperthwaite, formerly of Columbia College, and Shelby M. Skinner, now of the University of Chicago, have contributed to the work of this area.

[6] This is treated in the article by Paul B. Sears.

[7] This is developed by Duane Roller through material drawn from his larger manuscript on energy and power.

[8] This is treated in the article by F. L. Fitzpatrick.

[9] This is treated in the article by John G. Pilley.

[10] A source unit treating this area has been prepared by Gertrude Wylie Diederich, formerly of Horace Mann School, and this is printed as an appendix to *Science in General Education*, pp. 525-579, Appleton-Century Co., New York, 1938. Basic content for this area has been prepared by Joseph Schwab, Instructor in Science, University of Chicago, and by H. Bentley Glass, now of Goucher College. Both these men were Research Associates in the Bureau of Educational Research in Science during 1936-1937.

[11] Basic content for this area has been prepared by Professor F. C. Jean, of the Colorado State College of Education, Greeley.

ing in general. The roots of the ramifications of this generalization are found in common ideas on genetics, some true and some false, held by the "man in the street," as well as by children. In different aspects, including intimate personal contacts, government, education, physical and mental health, and world-view, this generalization is closely related to the situations and problems of life. We may therefore seek to develop in young people the traits and capacities helpful in dealing with them.

At almost every age children will know that offspring resemble their parents, that there is a difference between mongrel and pedigreed dogs, that eggs for "settings" are selected from favored flocks, and of the high prices paid for bulls and stallions. They have heard of red hair, drunkenness, bad temper, musical ability, and tuberculosis as "running in certain families." They have heard "like father like son," certain traits "skip a generation," "girls take after their fathers, boys after their mothers." They have heard "half-breeds" often associated with the statement that people of "mixed blood" inherit the worst traits of both races. Often they are taught to share an active "race" prejudice against people of a particular nationality, or language, or standard of living. They have heard people referred to as "born teachers," "born politicians," and "born liars."

There are emotional elements attached to their consideration of human beings that are not present in thinking about dogs or seed corn. This arises from the fact that particular groups or individuals may traditionally buttress their self-esteem with the help of particular genetical views (such as those of racial superiority) or may be made to suffer a feeling of inferiority because of direct or implied criticism from others. We see such emotions entering into the common misconceptions of natural selection and the survival of the fittest, the confusion of the poor and weak with the unfit, and the resulting belief, so often heard or read in these days, that "The poor ought not to be allowed to have children," "America is breeding from the bottom, not the top," "We shouldn't take such good care of the weak and sick as it simply allows them to stay alive and perpetuate their kind, thus going against natural selection and causing the race to deteriorate." This has seemed to be given scientific backing by the uncritical use of the stories of the Jukes and the Kallikak families in elementary study of human heredity.

The "principles" of genetics ramify widely into human interests, and for this reason it is important that we take stock of what is actually known about the things in life touched by them. Obviously many damaging misconceptions have arisen. Here we must use the best scholarship that may be commanded. Since our particular concern is with young people in the schools, we must learn as well as we can how fully these matters of general human interests are also the interests of the children in our particular classes. The principles will find application in the situations, interests, and problems met in the daily activities of the young people whom we serve. These considerations will guide us in planning approaches and materials and methods for teaching. Using technics of evaluation we shall study the processes in learning, seeking to determine how far we have been successful in helping young people attain specific information and skills that are useful in everyday life; to correct their erroneous concepts and achieve clearer insights into the meaning of the relations between heredity and environment; to attain command of careful and critical methods of thinking that have application in this area; and to develop specific attitudes, interests, and appreciations consistent with the best experience of the race in dealing with these matters. We shall study the effects of education in this area on overt behavior and its effects on ways of looking at life in general.

Learning to Use Science in Managing Our Lives

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THE original plan for the Bureau of Educational Research in Science was twofold: it provided, first, for drawing out from the findings of science those ideas having greatest significance for human beings; second, for experimental investigation of how children may be helped in school to explore some of these ideas with the greatest profit to themselves in the management of their lives. This article is primarily concerned with the second part of the plan, the study of processes and outcomes of learning in the field of science.

Through studies in educational psychology the Bureau has accumulated some information about learning. This has been gathered in laboratories or in school situations, where effort has been made to minimize differences between learners and to isolate specific learning situations and specific outcomes in numerically describable form. It seemed desirable to make a study of learning as it goes on in ordinary classes. To this end the cooperation of teachers who were professionally interested and skillful was enlisted, and an attempt was made to find what opportunities these teachers provided for their students and what learning went on in their classes.

COOPERATIVE STUDIES OF LEARNING

Our investigation was limited to a consideration of learning within the field of science by students in the secondary school, the seventh through

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the fourteenth grades. It was carried out with the cooperation of a number of teachers of science in New York; New Jersey; Washington, D. C.; Columbus, Ohio; Fort Worth, Texas; and Oakland, California. We asked the teachers who were cooperating for reports of their teaching which would show all the kinds of learning situations available to their students. We were not satisfied with a statement of experiments performed and pages read in textbooks, or even with a list of field trips and outside speakers. What did the class discuss? To what extent did students plan their own work? What questions or comments did they contribute which brought to attention new applications of what they were learning? By what questions or comments did the teacher direct attention to significant implications for thinking and for individual and social welfare? These were questions to be answered if we were to get an adequate picture of the learning experiences of a group.

To obtain a record of what a class does is extremely difficult, although it seems obvious that no study of learning is possible without a detailed picture of the situations in which learning goes on. First of all, it was necessary to have a description of the class itself since the effectiveness of the stimuli presented depends upon characteristics of the learners. We asked teachers to provide data as follows: (1) subject being taught; (2) grade; (3) number of periods class meets per week; (4) size of class; (5) sex distribution; (6) age range and average; (7) range of intellectual levels and average; (8) future plans; (9) economic, cultural, and social backgrounds; (10) any other characteristics of the class as a whole or of individuals within it which the teacher thought significant in their learning.

The time will probably come when studies of learning in classrooms will be carried on by means of talking motion pictures, thus making available for leisurely study fleeting impressions and sequences too transitory in their occurrence for adequate understanding. The Bureau has made a few studies to date of sound transcription of specific classroom situations. Expense and technical difficulties in preserving a natural learning situation are limiting factors in this mode of recording, although these seem by no means insurmountable. Another method of recording which has been used by the Bureau is that of stenographic reports. Our experience has shown these to be most useful when supplemented by

reports made by a trained observer, who selects from a complicated situation the more significant elements, who times proceedings, identifies speakers, and records movements, gestures, and facial expressions, thus making the total situation more understandable. Some teachers are able to make valuable records of what takes place in their own classrooms. This means making notes during the class period and amplifying and supplementing these immediately after class. The teacher's knowledge of the children and of the situation as a whole makes these notes, fragmentary though they are, more valuable than more voluminous reports from less enlightened observers. We have also used score cards in a few instances to obtain records of specific kinds of responses, particularly those involving formulation of hypotheses, organization of data, and other processes involved in scientific thinking. In the hands of a trained observer these have given excellent illustrations of opportunities for critical thought arising in classroom situations and of the responses which individuals make. Development of such score cards involves preliminary identification of the aspects to be observed. Hence their value in study of the learning process depends upon the reliability and validity of the original analysis.

For measuring results of learning, we asked our cooperating teachers to use whatever formal tests they could to discover changes in students' concepts, ways of thinking, overt behavior, specific attitudes and interests, and generalized attitudes toward themselves and the universe. We asked them, in addition, to identify those more indefinite and subjective clues by which they recognize such changes in students, realizing that these may constitute their most important contribution to the whole field of evaluation. Obviously, these latter measures of evaluation were not reserved for the end of a period of teaching. The records of what happened in classrooms were also the records found most useful for evaluation. Spontaneous questions and comments, sometimes facial expressions gave indications of how the students were thinking and feeling. Essays on general topics where the students organized and presented their own ideas sometimes gave surprising insight into their points of view and revealed confusions that no teacher would have thought of. For example, three teachers found a widespread belief among their junior high school students that the earth split off from the sun, cooled grad-

ually until it was possible for living things to develop, that after a succession of forms man and woman arrived in the persons of Adam and Eve, their descendants being the cavemen. Essays on such topics as the origin of the earth and evolution were most fruitful perhaps in revealing misconceptions involving scientific and pseudo-scientific ideas, but almost any significant problem showed itself valuable from this standpoint.

A STUDY OF THE LIFE SPAN—SUGGESTIONS FOR TEACHING

The second step in the work of the Bureau has been to organize the contributions from our cooperating teachers and members of the Bureau around large generalizations, to develop plans for more controlled evaluation, and to put the whole into form which may be useful to other teachers. The results we have called source units, or, more descriptively, "Suggestions for Teaching." A number of these are now ready for experimental use. We are asking teachers to select from them those suggestions for student activities which are best adapted to their classes and their teaching situations and to evaluate results not only in terms of the new facts students learn but in terms also of the way they use these facts in the daily affairs of living.

The generalizations which are used as organizing centers in the preparation of these materials are not in any sense statements to be learned. Each describes in a general way a wide field of knowledge and suggests its ramifications through thinking and feeling and acting. For purposes of general education it seems desirable to select generalizations whose implications ramify widely into human affairs. Such generalizations can never be completely mastered: some understanding can be gained at a very early age; graduate students and research workers can still find them profitable and stimulating fields of investigation.

As an illustration of what the Bureau is doing with material in several fields, suggestions which center about one generalization will be considered. The generalization chosen may be stated as follows: *Human beings, like all other living things, live through a characteristic life span; abilities and traits as expressed at any one stage of development are the resultants of native endowment, rate of maturation, the experiences through which the individuals have passed, and their unique responses to those situations.*

Implications of This Generalization

The implications of this generalization are twofold. They have to do first with our understanding of ourselves and other living things, and with our attitudes, which are based on this understanding. If our understanding is broad, consistent with reality, and integrated with all our other experiences of living, our attitudes become those of security and freedom from irrational fear, with full appreciation of our need for more knowledge. One measure of the importance of this generalization is the vast number of superstitions and erroneous conceptions which have always been associated with the phenomena of human life, especially its beginning and end.

The other implications, dependent on our understanding and attitudes, have to do with actions related to ourselves and to other people. Practically all of us must take responsibility for directing our own activities; practically all of us, as parents, teachers, taxpayers, or maiden aunts, must take responsibility for the lives of other people. This generalization relates directly to such action and responsibility and to helping us act more intelligently and sympathetically.

While we need understanding and carry some responsibility at every age, our interests and problems do shift as we grow older. As infants and young children our chief need is for orienting ourselves in the world of living things, especially the world of human beings. As adolescents we are likely to focus attention upon understanding ourselves and our place as individual personalities in the scheme of things, and we strive to establish independent relations with other people of our own age, with older people, and to some extent with younger people. As mature individuals we are called on to carry full responsibility for ourselves and, in large measure, for the young and the old of our families and our community. At the same time we try to make the fullest use of our powers for our own satisfaction and enrichment and for the contribution we can make to the welfare of others. In old age we are faced with the problem of working out a scheme of living which takes account of our interests and experiences and is within the limitations imposed by senescence. These limitations may bring us back full swing to the dependence we experienced as children and from which we emerged as adolescents, a dependence enriched now, however, by experience and understanding.

Almost all children and adults have had wide experience with living things and with their changes as they pass from one stage of development to another. The changes, however, are so nearly imperceptible that often the general idea of sequence of events through a life span is missed. Even the sudden changes of birth and death are so dramatic and so charged with emotion in and of themselves that their significance in terms of total life span is lost.

Young children ask, "Where did the kittens come from?," "Where did the baby come from?," "Why can't I be as big as you?," "Why can't the baby eat what I eat?" All the experiences of being weighed and measured, of changing bed hour, of losing baby teeth and getting new ones, of puberty and the development of secondary sexual characteristics are common experiences which are, however, for the most part considered in isolation. Very young children know that older people are stronger, know more and can do more things than they; and they begin very early to say, "When I am grown up. . . ." They know and accept without questioning that grandfather's hair is gray, his teeth are false, his steps are slow, he must put on glasses in order to read, you must shout at him if you are to be heard. Quite apart from this, however, in their thinking are mother's worries about gray hairs and wrinkles, and father's plans for a future when he "won't be able to work any more." They do not put together what they know, to give a unified concept of life as a whole.

Young children also ask, "Why can't the birdie sing any more when it is dead?," "Where is Grannie gone?," "Why are you crying?" And in general the emotional responses of adults to death and to the thought of death are so overwhelming and contagious that the children cease their questioning and refuse thereafter even to allow themselves to think about this mysterious and dreadful thing. Simplified theological concepts with regard to the hereafter, as inculcated in Sunday school, add to, rather than dissipate, this confusion.

Children who grow up in the country amid the constantly recurring seasons of planting and harvest, of the birth of new animals and the marketing of the mature, have a broad background of experiences for understanding the general concept of generation succeeding generation, each living through its own life span. However, experience with harvest-

ing and marketing gives little understanding of old age and death as natural and inevitable sequences of the life span. Likewise, children with pets, while they may accept the fundamental facts of reproduction as part of a natural scheme of things, are likely to think of death as the catastrophic result of disease or accident. Even the annuals in our gardens are cleaned out each fall before the fading flowers and drooping leaves of senescence become an "eyesore."

As for the significance of developmental stages, our common knowledge is extensive but confused and often so focused upon ourselves as to contribute little to broad concepts.

We label certain actions "babyish," "childish," "adolescent," but almost always the terms are applied in such a critical or derogatory sense that they carry little or no connotation from the developmental stages which give them name. "You're a big boy now; only babies do that," "Be a little man; men don't cry" are hortatory rather than descriptive and, being recognized as such, confuse rather than clarify ideas of difference between babies, boys, and men.

At puberty it seems as though more attention is centered upon developmental changes and their significance, but here the implications are so personal that general concepts are difficult of achievement. The adolescent is likely to be overwhelmed by his own physiological changes and by his own emotions, engrossed in his desire to be like other people and to achieve social acceptance, and worried by the future. The broad concepts which might do most in giving him perspective and understanding of his own development are lost sight of in the insistent drive to get immediate and personal answers to immediate and personal questions. And his confusion and lack of understanding of himself and his abilities are matched by those of adults who at one moment tell him, "You're grown up now, you must take some responsibility for yourself and other people," and at the next exclaim, "Why, of course, you're not old enough to take the car."

As mature adults we still fail to think in terms of developmental possibilities. Some parents treat their children as animate toys, irresponsible, to be petted, spoiled, and punished as whim and circumstances suggest without regard for the children's slight but growing ability to take responsibility for themselves. Others expect mature judgment from the

immature and take no account of the effects of this expectation and its inevitable disappointment on their children. This is perhaps most conspicuous in their dealings with their adolescent children, since a fifteen-year-old looks like an adult, may talk like an adult, and in many ways has the same wants as an adult. Yet he may be far from adult in his feelings and experience.

At the other end of the life span we fail to recognize the inevitable changes brought by the years, both to ourselves and others. We hold ourselves and our parents to the standards of efficiency and achievement to which the long years of maturity have accustomed us. If we do take account of the calendar, it is with grief at the limitations we discover, without recognition of the increased perspective and understanding experience may have brought.

Immediate Interests in the Life Span

The foregoing examples represent the experiences and ideas we can expect to be the possession of most people at one age or another. Learning activities, however, should be provided for individuals with special reference to their own background of experience and interest, whatever those may be at a particular time.

In our "Suggestions for Teaching" we list some questions which have been asked by students in order to give teachers an idea of the wide range of interests and problems their students may show. "Where do babies come from?" is oft repeated at many ages. The longer a child is put off with fanciful tales of the stork, the doctor's bag, or the rosebush, the more he is confused and the more erroneous concepts and attitudes will he possess. "Can babies be 'marked' before birth?" "Should children be spanked?" "Am I like other people?" "Are adolescents erratic, flighty, irresponsible?" "Should adolescents pet?" "What are my chances for a job?" "How can I keep from getting gray hair?" These and hundreds of other questions give clues as to the questioner's interests and show the teacher where and how to start in a particular situation a unit on the human life span.

Trying to capitalize the immediate interests of students and guide them to broad understanding of human affairs leads at once to the discovery of the limitations of traditional textbooks and of material organ-

ized according to the traditional disciplines. Perhaps more than in other fields workers in science have tended to remain aloof from human problems, to make discoveries and inventions and carefully refrain from considering what these same discoveries and inventions may mean for human good or harm. One part of the work of the Bureau of Educational Research in Science has been to organize and make available some of the findings of science in terms of their personal and social significance. Such material regarding the life span draws from many logically organized fields, such as physiology, anthropology, genetics, embryology, biochemistry, and is so organized as to give better understanding of human development as a whole and the factors influencing it.

Introducing a Class to the New Field

Having in mind then the immediate interests of his students, the wider implications of our knowledge of the human life span, and an organized body of relevant knowledge drawn from many disciplines,[1] the teacher is ready to introduce his class to this new field. There are numerous ways in which he can stimulate their interest and direct their attention to this phase of human knowledge. In the "Suggestions for Teaching" we present several ways of starting work from which a teacher may choose or which may encourage him to find others even better suited to his class. This introduction should be one which directs attention to the whole life span rather than to an isolated segment. For example, any living thing can be presented to the class and its past and future discussed. A human baby is perhaps most useful here as it will rouse interest and will stimulate discussion of how babies become adults and the many factors, controllable and uncontrollable, which have their influence on the kind of adults they become. The Dionnes, Shirley Temple, Princess Elizabeth, and other famous children can be used to challenge thought along the same lines. Descriptions may be brought in of human beings of different ages, and art and literature may be searched for examples of the changing characteristics artists see through the life span. A pre-test may start the class thinking of the way people of different ages respond to the same situation—climbing stairs, for example, or being in the dark. The re-

[1] See especially Paul B. Sears, "Growth and Development" (mimeographed); Alice Keliher, *Life and Growth*, Appleton-Century, 1938; Bernhard J. Stern, *The Family: Past and Present*, Appleton-Century, 1937.

sponse of a five-year-old to the term "ice cream cone" differs markedly from the response of a fifty-year-old; "William Jennings Bryan" may still be "fighting words" to a seventy-five-year-old and carry no meaning whatsoever to his fifteen-year-old grandson. Such examples direct attention to the role of experience in determining thought and emotional responses. Discussing the ages at which baseball players, ditch diggers, business administrators, doctors, and others should retire gives perspective to consideration of the development and decline of muscular coordinations and intellectual achievements. Statistics on the changing length of human life in our civilization can be used to stimulate discussion of the ages at which jobs are available now, and will probably be available in five, ten, or twenty years from now, when these students will be entering the working world, and to bring about more realistic consideration of retirement laws, old-age pensions, prolonged education, and the deferment of marriage. Any of these introductions can be used to give perspective and a broad view of the whole of a human life.

Learning Activities

The succeeding activities of the students will be determined in part by the introduction, in part by the special lines of interest they wish to follow. The teacher should be ready with materials, suggestions, questions. The "Suggestions for Teaching" offer a rich variety of activities from which teacher and class may choose, or which may set them to thinking of other possibilities. Some classes may wish to study the stages in the human life span chronologically, starting with prenatal life, and following through stage by stage to senescence. Others may start with one stage, infancy, perhaps, or adolescence, and work forward into the stage of maturity, returning to a consideration of prenatal life toward the end of their study. Still others may wish to study the development of one trait through the whole life span; growth in size, for example, or intellectual development. Whatever the sequence of activities, the teacher must be responsible for a broad viewpoint, for the relation of details to wider and wider generalizations, and for making sure that the applications of our knowledge to human affairs are recognized.

We can assume that normal human beings desire their own welfare and that of other people; we can assume that they can modify their

ways of thinking and feeling and acting in the light of new knowledge. We cannot assume that they will always see the applications of knowledge to human affairs or be able to select the ways of thinking, feeling, and acting most conducive to welfare without encouragement, practice, and leadership. Teachers cannot understand all that our present knowledge would mean if it were actually applied in the management of our lives—nor could the wisest person living—but they can direct attention to the possibilities they do recognize and can set their students free to think for themselves. Thus we can hope to bring up a younger generation who will attack the problems of living with greater perspective, as well as more knowledge, than their predecessors.

In the field we are considering specifically, learning activities should include a maximum of firsthand experiences with human beings of all ages. They should take students into the community to study the influences under which people of various ages work and play. They should include study of families and of young children, of vocations, of community care for dependents, of education itself at all levels. Laboratory provision should be made for studying the basic physiological and psychological aspects of human beings. Students should be introduced to the literature in the field and should evaluate critically the multitudinous interpretations of human behavior and recommendations for modifying it. They should examine superstitions and common beliefs critically in the light of all our available knowledge.

To achieve the widest understanding and the most desirable attitudes with respect to the human life span, the study of individual children over a period of several months or years affords some of the best learning situations and an appealing center of interest. Not only is attention directed to a child's characteristics as shown at the time of study, but inevitably the student's mind is drawn ahead to his future and to the problems of safeguarding and enriching his life throughout his development as a person.

Instruments for the Study of Learning and for Evaluation

The "Suggestions for Teaching" also include suggestions for evaluation of the results of teaching. These are both formal and informal. Paper and pencil tests may be used to advantage in testing knowledge

and to some extent in testing critical thinking in this field. Observation of behavior is almost the only means of discovering changes in the way children act. Accounts by the children or by their parents of what they do in caring for themselves, for younger children, or for older people may be reliable measures of changes in their behavior. Recording of questions and comments and incidental statements in various written and oral reports are almost the only way of discovering changes in attitudes, although there are now being developed some paper and pencil tests for measuring these.

Attitudes and feelings teachers might be on the lookout for in their students are: satisfaction in having questions about birth and life answered honestly and in knowing where further information is obtainable; freedom from superstitions concerning prenatal influences; satisfaction that their own development is, in general, normal, and freedom from undue worry about their own physiological and emotional changes; freedom from irrational fears of old age and the idea of death, and acceptance of the idea of inevitable limitations brought by old age; respect for the findings of science in this field and interest in having these findings used for all the children, dependents, and old people of the community; appreciation of the changes in vocational opportunities, family life, and the status of women, due to the lengthening of life expectancy and the falling of the birth rate. Some students may develop vocational interests in the care and education of children, medicine, or nursing, as a result of working in this field. From the standpoint of lifelong results of learning these philosophical and vocational interests are of supreme importance and must not be neglected in a plan for evaluation, even though techniques for discovering and describing them are few and lacking in precision.

The foregoing illustration has been developed at some length as a more vivid means of presenting this phase of the work of the Bureau than prolonged general discussion. Suggestions for teaching other than the one centered about study of the human life span have been prepared or are in process of preparation in the biological and physical sciences. These all follow the same general pattern. A large generalization is stated and its implications for human welfare are described. Specific questions which children of various ages have asked in relation to the

material are quoted to serve as hints to teachers of what may be the questions and interests of the classes they happen to be teaching. A third section describes a variety of possible activities by which a teacher and class may begin the exploration of this new field of knowledge. This is followed by an extensive outline of activities, varied as to kind of materials used, varied also as to the levels of interest and ability to which appeal is made. From these it is hoped teacher and class will select those most suitable to their situations and most significant for their way of living. The last section contains a variety of suggestions for evaluating the results of exploring knowledge in this area. Effort is made to draw attention to some of the intangible but significant fruits of learning: changes in overt behavior and in attitudes and general views of life. Although techniques in evaluating these outcomes are admittedly imperfect it is important for teachers to use those that are available. It is our hope that teachers will find these suggestions for teaching and evaluation challenging, and will in turn contribute the fruits of their experiences in using this preliminary material to make later units more practical, more clearly focused, and more effective.

Implications of Our Knowledge Concerning Biological Production and Control

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TWO of the great biological urges are to eat, and to avoid being eaten. These are even apparent in the case of man, though in the confusion resulting from studying the minutiae of human behavior, we do not always see the proverbial forest because our view is obstructed by so many trees. But now and then we encounter suggestion that political units may even go to war in an effort to secure more of the world's goods, including food, or to protect their possessions against similar intentions of less-favored nations. This indicates that the first of these urges may be a driving force that motivates human behavior, finding expression not only in acts of the individual, but greatly affecting the course of nations and society as a whole.

MAN AND HIS ENVIRONMENT

Primitive man was generally dependent upon the environment for his food supplies, and for that matter, some groups of mankind remain essentially in a hunting and fishing culture today. However, political and racial groups that have made more substantial progress have developed more dependable sources of biological materials, including foods. These are largely based upon successful cultivation of plants and domestication of animals. But even the most advanced cultures continue to draw upon the environment for many biological materials.

Undoubtedly the early agriculturalists followed somewhat hit-and-miss procedures. Apparently they recognized the desirability of raising certain kinds of plants and animals. Probably they were aware that such

efforts were often hampered by the presence of competing species, such as weeds and many of the insects. But they had no very effective means of dealing with such problems. They saw through the glass darkly, making progress slowly along some lines, and little or no progress along others. There is evidence, however, that some of them practiced a species of mass selection, from the results of which we profit in modern times.

Time has passed, human knowledge has accumulated, and the scene has undergone great change. Modern science provides us with techniques of biological production and utilization that were undreamed of by the ancients. We have methods of Mendelian selection and of hybridization that yield relatively rapid results. We have greatly improved methods of food preservation. We have far greater knowledge concerning competing species, and of certain chemical, mechanical, and indirect methods of effecting desired controls. We have even begun to experiment with the chemical garden, and with the production of basic food in the biochemical laboratory. We could do a better job of biological production than we are doing today if all available scientific knowledge were generally put to work. The fact is, however, that practice lags behind the frontier of knowledge.

In the past hundred years we have learned that it is entirely possible for the individual to go ill-nourished in the midst of apparent plenty. Sometimes the explanation is purely economic. In other instances the economic factor does not operate to an appreciable extent, but the individual remains ill-nourished nonetheless. The great progress that has taken place in the field of nutrition has not as yet been fully capitalized upon. In part this may be because so many pseudo-scientific and faddistic diets flourish in our midst. No doubt it also is due to the fact that certain information has not become widely disseminated. Many people appear to possess vague awareness that problems of diet exist, but few show outward evidence that they have clear understanding of these matters or their implications.

In the area of production and control we are beginning to realize that man himself is one of the most destructive organisms that has ever dominated the scene. He often has regarded the environment as his oyster, to be exploited in any manner that suggests possibility of immediate profit. When man has come into a new environment he commonly

has brought with him a retinue of cultivated and domesticated forms, and a long list of camp followers. Not content with that, he has destroyed native species and has altered physical conditions, often without knowledge or appreciation of possible consequences. The general effect has been an unbalance of nature, which in the end tends to restrict production and makes the control of competitors more difficult to achieve.

It is also more or less admitted that the survival urge is an important factor in determining human action. We prefer not to be killed or injured as a result of accident or intent. When natural enemies of man are mentioned, however, many people seem to feel that these must be a thing of the past—that they may have been a problem to the cave-dwelling Cro-Magnons, and may remain a minor nuisance to bush-dwelling aborigines, but that civilized man has long since learned how to deal with them effectively.

This is an optimistic point of view not wholly supported by the facts. To be sure, most of our larger natural enemies have been brought under control. Modern man need no longer lie awake in his cave or before a blazing campfire at night, fearing attack by carnivora that prowl in the shadows. But these were never the most dangerous enemies. Man had one satisfaction and comfort in that he could see them coming, albeit he sometimes saw them too late.

The most deadly potential killers, however, have been and are the smaller parasitic organisms. Their identity has been unknown and largely unsuspected throughout the greater part of historical time. It is less than three hundred years since the city of London was practically abandoned because the populace had no defense against bubonic plague except a vague realization that the open country offered the only hope of sanctuary. Less than a century ago Pasteur, Lister, and others were beginning the investigations that have borne fruit in a modern science of preventive medicine. Imperial Rome and medieval Europe had successively been decimated by bubonic plague, malaria, tuberculosis, smallpox, diphtheria, puerperal sepsis, and other infectious diseases. These pestilences had mocked Greek and Roman cultures; they had limited the average life span to about twenty years during the Middle Ages.

Many of the small organisms responsible for such diseases are now known to science. Enlightened people no longer regard an epidemic as

a visitation of Providence, or as the work of witches and well-poisoners. What was once referred to as the "germ theory" of disease now carries with it the dignity of an established concept.

Ways and means of combatting the unseen enemy have been discovered. The foremost consideration is to keep the parasite from becoming established in human tissues, where it may destroy the host as surely as would the hungry tiger. Failing that, it is sometimes possible to eliminate the entrenched parasite without effecting disaster upon the host.

Life in the modern city not only has become tolerable, but has been made comparatively safe. Plague, malaria, typhoid fever, yellow fever, smallpox, diphtheria, and a number of other diseases need no longer be greatly feared in communities where adequate controls are maintained. It is obvious that some very important parasites still elude the best efforts of research workers, but progress is being made and will be made in the future.

In large measure our comparative security from parasites that are known or thought to produce certain diseases is based upon the existence of health safeguards. These are too diverse to be discussed here, but they include such factors as preventive inoculation, control of transmission agencies, provision of pure food and water supplies, adequate diets, sanitary disposal of garbage and sewage, quarantine measures, the use of certain drugs, licensing of physicians and pharmacists, and provision for hospitalization.

Such immunity from the attacks of parasitic enemies is only comparative, as we well know. We do not control this phase of environmental contact, and the partial control that has been established is maintained only at the cost of eternal vigilance. Moreover, many people seem only vaguely aware that the modern community might rapidly revert to the pestilential conditions of medieval Europe if health safeguards were not continued.

Even though preventive vaccination and inoculation have proved effective in reducing incidence of diseases such as smallpox and diphtheria, there remain many people who either are indifferent to the matter or who actively resist immunization of their children. Anti-vaccination societies still flourish. The layman continues to purchase extensively advertised nostrums which cannot possibly cure his real or

fancied ills. Often his methods in dealing with cuts, bruises, burns, and other accidental injuries leave one to marvel that the death rate traceable to accidental causes is not higher than its present imposing total.

The general thesis of this area is the relationship of what we have learned to problems of production and control. To put it another way, it is the area primarily concerned with wise participation in, and use of the environment. In dealing with the materials of the area, which are drawn from a number of rather highly-specialized scientific fields, it has seemed both practicable and desirable to group them into three sub-areas.[1] These are as follows:

1. Problems centering about the production and use of biological materials, including foods and other articles of commerce.
2. Problems concerning the control of competitors, which are here defined as those organisms that destroy or tend to destroy materials man might otherwise use.
3. Problems relating to the control of natural enemies, which are interpreted to be those organisms that make direct attacks upon man, and are known to be responsible for a long list of human ills.

The writer is not inclined to think of these sub-areas as "units of work" in any particular instructional situation. Admittedly they might be developed as such. Their highest educational utility, however, probably resides in the potentiality that students may be led to an increasing understanding of the important concepts involved, not at any particular grade level, but throughout the educational experience. Moreover, at the present stage of development, they are merely more or less coherent groupings of facts, concepts, and practical applications assembled and interpreted from such sciences as agronomy, genetics, economic botany, bacteriology, protozoology, parasitology, pathology, economic zoology, forestry, ecology, and helminthology. In the pages that follow let us attempt a brief examination of special problems within these sub-areas.

BIOLOGICAL PRODUCTION

In last analysis the economy of any community is based upon the physical conditions obtaining in that community. These set the stage

[1]These areas are being developed in a manuscript to be published in the near future.

for the drama of life; they vary from season to season, and from one moment in time to the next. We have learned that the action and interaction of these conditions is subject to the operation of natural laws, some of which are understood to a greater or less degree. We are able to effect some modification of certain conditions; others elude us even though we strive to gain control over them.

The fundamental concern becomes one of utilizing the environment most effectively, not only at the moment, but also with future productivity in mind. More specifically, some of the problems of this sub-area are the following:

1. What methods have been employed in developing successful cultivated and domesticated types, and along what lines might it prove profitable to extend such cultivation and domestication?

2. How can mass selection, Mendelian selection, and hybridization be used to improve and perfect cultivated and domesticated types?

3. To what extent can we depend upon the natural environment to supplement the food supply and to furnish certain useful materials of commerce?

4. What wild or cultivated biological materials can be used as raw materials of modern chemistry?

5. What biological materials *could be* used, as compared with those that *actually are* used?

6. What cultivated and domesticated types can be raised most successfully under a given set of environmental conditions?

7. What present trends would result in reduction or destruction of organic resources if allowed to continue?

8. How may the natural environment be maintained and kept productive?

CONTROL OF COMPETITORS

Our most important competitors are to be found among the bacteria, the spirochaetes, the parasitic protozoa, the molds and some other fungi, the many species of parasitic worms, the insects, and the rodents. Some of these competitors eat cultivated or uncultivated plants that could otherwise be utilized by man. In other instances they are parasitic on or within plant and animal tissues. Thus they tend to destroy many forms

of life that could be used as human food or to supply various materials of commerce. Still another group of competitors are saprophytes, capable of destroying organic materials, including foods. Taken collectively our competitors make enormous inroads upon organic resources, and, in addition, some of them are intimately concerned in the transmission or production of certain diseases.

No one can doubt that the control of competitors represents one of the more important phases of human activity. It involves the annual expenditure of much time and money. We are not only confronted with the necessity of producing or acquiring a certain amount of organic material each year, but there is also the question of *what* this organic material shall be. There is further question as to its quality; materials that have been subjected to the attentions of competitors rarely are first class. The challenge of an economy of plenty is not only to produce enough, but to provide first-class materials in something approximating the ratio set by the needs of society.

In this sub-area, as in others, we cannot afford to think only in terms of the moment. As far as production at any one time is concerned, it may or may not be adequate, and the materials that result from such production may or may not be of satisfactory quality. But these are by no means the only important considerations. We must inevitably be conscious of the potentialities inherent in a geometrical ratio of increase. The relatively inconspicuous, but uncontrolled competitor of the moment may well be a major economic threat of tomorrow.

Some of the more specific problems of this sub-area are listed below:

1. Which organisms are our most important competitors?
2. Why do some insects and other organisms become pests? Why is it sound economy to control their numbers?
3. How may knowledge of life cycles, interrelationships, and food habits be used to advantage in establishing controls?
4. In what cases can poison sprays, poison dusts, poison gases, and poisoned baits be used to effect desired controls? What are the hazards involved in the use of such compounds?
5. What chemical substances can safely be used to control internal or external parasites?
6. What native elements of the fauna serve as natural controls?

7. In what cases may the introduction of control species be desirable?

8. In what cases will quarantine measures serve as effective controls?

9. In what ways are problems of conservation related to the control of undesirable organisms?

10. In what ways may the balance in nature, or a lack of such balance, affect the control problem?

11. Will it ever be possible to have permanent control of all competitors?

CONTROL OF NATURAL ENEMIES

Normal metabolism of the human body may be deranged by the presence of organic poisons, of parasitic organisms, or of toxins produced by these organisms. Such derangement results in ill-health and sometimes in death. Under the definitions we have been using here, the responsible organisms would be classed as natural enemies, because they make direct attack upon man. Many of these natural enemies have been identified. They are to be found for the most part among the bacteria, the spirochaetes, the protozoa, and the parasitic worms. Their control is a primary concern of the individual and of society.

As previously intimated, the first line of defense is to prevent such organisms from becoming located in or upon human tissues. The means of prevention range all the way from immunization or the use of antiseptics to the employment of purely mechanical devices, or the establishment of quarantine measures. An understanding of such matters would seem to be a requisite characteristic of the layman in a democratic society. The second line of defense is necessarily to destroy parasites after they have become established in human tissues. Here the concern and responsibility must be vested largely in the physician. However, a general understanding of the basic principles can do the layman no harm. It may even enable the latter to cooperate more intelligently with the man of medicine in efforts to meet the situation satisfactorily.

Some problems of this sub-area are the following:

1. In what general ways does the presence of germs and other parasites affect metabolism of the human body?

2. How may the natural defenses of the human body be strengthened and supplemented?

3. What effective safeguards may be employed in protecting the human body from parasitic invaders?

4. To what extent are insects and other animals involved in disease transmission? What is the significance of such facts in terms of control?

5. How is human metabolism affected by various types of venom and by certain plant poisons?

6. What effective chemical compounds can safely be used to destroy various parasites?

7. What community actions are necessary in safeguarding the health of a population?

SUMMARY

In a word, the thesis of biological production and control is to apply biological knowledge in the solution of problems which are related to the physiological and economic welfare of mankind. Frequently such problems appear to involve only the conduct and welfare of the individual. Closer examination of the situation usually indicates, however, that they also are problems of society. Again we are reminded that man is a part of the organic community in which he lives; he is not exempt from the laws of interrelationship, he cannot repeal such laws by legislative means, and actions of the individual initiate series of events which ultimately may produce unforeseen and unwanted effects.

Some errors of commission and omission bring disaster only upon the individual who makes them, or upon the family of which this individual is a part. Most of them, however, are potential sources of hazard to every member of society, no matter how enlightened his own behavior may be. The farmer who destroys the forests on hillsides, or plows up the dryland sod may bring disaster not only upon his own acres, but upon the surrounding territory as well. The farm- or home-owner in wheat growing areas may harbor the common barberry on his premises to the great injury of his fellows. The farmer who allows various pest species to flourish upon his land makes that land a source of infestation for the entire area.

The tourist who carelessly gives origin to forest fires and the person who sets such fires deliberately are enemies of society. They destroy resources, they may destroy life, and the damage done often is more

lasting than is commonly comprehended. A similar menace is the individual who essays the use of poisoned baits or poison gases, or poisons of any kind, without knowledge of dangers inherent in such practices.

The community which dumps sewage into streams does an injustice to its own citizens and many others in near-by regions. The old-fashioned city dump represents a potential source of rodent-infestation for the entire region. The home-owner, storekeeper, or apartment dweller who permits mice, rats, cockroaches, bedbugs, lice, fleas, clothes moths, and similar familiar pests to find refuge on his premises provides a ready source of re-infestation for surrounding homes and apartments.

Despite the great advances made in the field of disease prevention, many individuals indicate by their actions that they do not understand or are indifferent to the principles of health preservation. The casual attitude or social blindness of many people with regard to dissemination of infectious diseases is chronic. The prevalence of syphilis in society is one of the greatest disgraces of modern times. Methods of reducing the incidence of uncinariasis, malaria, pulmonary tuberculosis, influenza, and certain occupational diseases are known, but often are ignored in human conduct.

What seems to be needed is an awakened consciousness with regard to problems of production and control. We can and should produce sufficient biological materials of acceptable quality, and in suitable ratio from the standpoint of our needs. We have made progress in efforts to control our competitors and our natural enemies, but in the light of modern knowledge we can do better than we are doing; too often the positive actions of some individuals or groups are nullified by the negative attitudes or behaviorisms of others. We must have an understanding of the community and its interrelationships which includes man as a part of that community, and not merely as an exploiter of natural resources at the moment, which fosters permanence and dependability of production, which envisions more lasting and effective control of competitors and natural enemies.

There is no disposition upon the part of the writer to claim that education can correct all of the abuses that exist within these phases of human conduct. But the specific information of science which relates to such conduct can be organized and related to a number of concepts

and generalized insights. It is to be hoped that contact with these may produce certain generalized attitudes and insights upon the part of many people, which may be guiding forces in determining their behavior. Here lies the task of education, even though many details of operation and procedure must be left in the hands of technical experts.

Probably there will always be some people who lack the ability to comprehend—whose mental and physical inertia resists the best efforts of a directed educative process, even when their economic welfare and their health or survival are at stake. It is to be hoped, however, that this group constitutes but a small minority. Meanwhile it seems obvious that the educational program of a democratic society must arm the individual with insights and understandings regarding production and control in order that the acts of individuals and the decisions of groups may be guided by comprehension rather than by prejudice and the indifference born of ignorance.

Man's Use of Materials and Energy

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NO small proportion of the grumblings back of the stage of education in recent years has centered around objections to the time-honored process of presenting isolated bits of repertoire to the public. The old method was to present the educational material as a twelve- or sixteen-year-long vaudeville performance, every act separated from every other, so that not even the management could see any connection between the parts. Whether we like to believe that all the world's a stage or not, we have come to see that real life is a play of reality with many interconnecting threads, even if there is no predetermined plot. It is not a series of isolated vaudeville acts. Hence, if the purpose of education is to prepare the student for living in the modern world, the presentation should be that of a well-balanced, interconnected pattern. The period of isolation in the educational world seems to be on the way out.

INTERRELATIONS IN MODERN LIFE

To be a bit more specific: the art, philosophy, and ethics of the modern world have been profoundly affected by the developments of science; and the converse has, to a certain extent, been true. It becomes daily more evident that one cannot have a broad grasp of life unless he has some slight comprehension of science and its implications. One of the objects of this work of the Teachers College Bureau of Educational Research in Science in presenting a series of monographs has been to put

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Other works by Professor Furnas bearing upon the general problem of technology and its social implications include: *The Next Hundred Years,* Reynal and Hitchcock, 1936; *Man, Bread, and Destiny* (in collaboration with S. M. Furnas), Reynal and Hitchcock, 1937; and Section VIII ("Metallurgy") of Part III, *Technological Trends and Their Social Implications,* Report of the National Resources Committee, 1937.

science in its proper place as part of the true living framework to show that it does not stand alone in human existence.

Just as scientific developments are intertwined with other lines of activity, so the various branches of science are interrelated, and should be so taught. This is against all the traditions. For many years no one ever questioned the reasonableness of presenting mathematics, chemistry, physics, botany, zoology, or geology as separate and distinct bitter pills, each one made up by a different formula. The concepts, enunciated principles, and even the jargon varied widely from one monastic cell of learning to another. Eventually, the experts in the various lines found that they were handicapped by the narrowness of their own specialization and began to seek help from other scholarly monks in other cells. Hence, the rise of the polyglots, such as mathematical physicists, physical chemists, biochemists, biophysicists, geophysicists, and geochemists.

On one occasion I sat in on a meeting of presumably competent mining geologists who were holding controversy on natural processes involved in the evolution of an iron silicate mineral into an industrially important deposit of iron oxide. The debate grew acrimonious and personal, and high-sounding mineral names, such as glauconite, chamoisite, hematite, and limonite, were used as weapons. No mention of the chemical composition of the compounds was brought into the two hours of turmoil. Yet it was perfectly obvious that some elementary chemistry was the basis of the natural enrichment of the ores. With misgivings I arose and stated the obvious fact that the debate should start with a presentation of the simple chemical reactions which must be involved. I was informed that chemistry was a frill and a waste of time, something one got credit for twenty years ago and promptly forgot. As far as I know these men may still be arguing because of lack of understanding of fundamental tools. They had been trained in a system that recognized no connection between different branches of knowledge.

The story of the search for a material to prevent the ravages of diabetes is a long and pitiful one, pitiful because hundreds of thousands of diabetics died while waiting for the successful completion of the search. The proper curative material did not become available until a group of men at the University of Toronto looked beyond the methods

and jargon of medicine and took up the methods of physics and chemistry. By turning into physical chemists they devised a way of extracting the active principle of the pancreas gland in sufficient purity to be used for human medication. Not until the research stepped beyond the traditional fields of medicine was it possible to produce insulin for the use of the human race.

These examples of the necessity of broadening investigation to include other fields than the one immediately at hand could be cited by the hundreds. Most investigators have learned of this necessity only after their formal education has been completed.

If the oldsters in the field of science have found it necessary to go out and break down the connecting walls between the various branches of knowledge, it seems logical to break down the walls before they are built, that is, when education is begun.

OBJECTIVES OF MONOGRAPH

As I wrote the book on *Man's Use of Materials and Energy from the Earth's Crust*[1] I tried to keep two objectives in mind. First, to present old materials in whatever framework seemed logical even if it were unconventional. Second, to point out the sociological effects of many scientific and technological developments. The volume is not a textbook, but it is hoped that some students may find it worth reading. It is written primarily for teachers, but it contains no rules for teaching. Its prime purpose is to enrich the background of those who read it. If it does that, then it will broaden the vision, if not the knowledge, of the reader. Broadening of background should lead to improved teaching and improved learning.

THE SUBJECT MATTER

The title of the book, *Man's Use of Materials and Energy from the Earth's Crust*, is descriptive, though sparingly, of the contents. This volume describes briefly the raw materials of the universe with which man has to work, and what he does with them, both technologically and sociologically. It offers a few suggestions for improving some of his processes, both technological and sociological. That is all; but it's an

[1] Now being prepared for publication by the Bureau of Educational Research in Science.

encyclopedic subject, necessarily handled in a sketchy fashion. For its field, it ranges over that entire film of the universe made up of a layer of rock and water about ten miles thick and a layer of atmosphere ten miles or more thick, extending over an area somewhat less than two hundred million square miles—the crust of the earth. There man lives and there he works, fights, begets, plays. He exists only by virtue of the raw materials which are available to him there. I contend that a reasonable knowledge of these raw materials and how they are and can be used is a prime requisite of the well-educated person. I also contend that the educational experience of the student will be more meaningful if he views the physical and social phenomena involved in a loosely integrated mental panorama than if he soaks up knowledge of the separate parts in numerous isolated cells.

Every voting citizen is now called upon periodically to cast a ballot for or against men who hold certain views in regard to the utilization and conservation of our energy resources. No person can vote intelligently on such an issue unless he has some idea of what energy is, how we use it, where it comes from, and how long it may last. Such knowledge, cursory though it may be, should be part of the background of every voter—hence the inclusion of a section on "The Energy Supply."

Formal histories narrate in monotonous tones how civilizations have risen and fallen. The explanations of the cycles of civilization usually revolve around military exploits. Yet further digging-in reveals that such a prosaic thing as food supply was often highly significant. The boasted fertility of American soils is barely holding its own; in an alarming number of instances it is on its way down. Is America about to go over the peak because of increasing sterility of the soil? If so, can we, here and now, do something to stop it and change the natural course of history? One cannot have a valid opinion on the subject unless he knows something about "Feeding Hungry Plants," which is discussed under the topic, "The Chemical Age."

These are but two examples of the approach to the subject matter which may reveal the attitude of the author.

The subject matter cuts across the conventional fields of geology, physics, chemistry, and various branches of technology, with some indications of the economic and sociological inferences of recent develop-

ments. I do not mean to imply that it is a complete treatise of any field of study. It is merely an outline, a skeleton on which to hang intensive bits of work. I am a person who believes that one does not learn chemistry and physics without studying the laws of chemistry and physics in considerable detail; but I also believe that such studies are much more valuable if they are pursued with a comprehension of their relation to man and his activities. It is intended that this book shall, in some as yet unknown way, help to supply such a background of interrelationships. This is only in keeping with the now generally accepted idea that one of the prime functions of education is to produce useful citizens.

The major points of the outline of the contents are:

I. The Raw Materials
   A. The Chemical Elements
   B. The Sources of Energy
II. The Formation of Ores
III. Discovering, Recovering, and Concentrating the Minerals
IV. Winning the Metals
V. Properties of Metals
VI. Use and Misuse of Metals
VII. The Nonmetallic Minerals
VIII. The Energy Supply
IX. The Chemical Age
X. Social Impacts and Implications
   A. Changes of Importance to the Individual
   B. Changes of Importance to the Group
   C. Untangling International Snarls

ATTITUDE OF WRITER

This outline merely indicates the breadth of the field; it does not indicate the manner of handling the material. The attitude taken by the writer is that man is an impostor on the earth. The earth got along very nicely before man came; it will probably breathe a sigh of relief when he is gone. Nature never intended (if nature ever intends anything) that there should ever be more than a few million human beings on the face of the earth, or that they should ever live any more extravagantly than the other beasts. But man evolved into something sapient and he now upsets many of the nice natural balances. He cuts the trees, allows the land to erode, takes the mineral fertility from the soil and

does not replace it. He combats the scourge of disease, and breeds endlessly, and laughs at the warning finger of Malthus. Western civilization is built on metals, on a few trillion tons of coal that nature has provided, on a relatively few billion barrels of petroleum. When these are gone, must man revert to an unhappy primitive beast with a brain too large for comfort, or is there some way out? That is a question which it is the duty and privilege of every intelligent future citizen to consider.

Man has cooked up a number of problems for himself; he is just now beginning to realize how many. In many instances he can combat the depletion of certain raw materials by using satisfactory substitutes. In other cases he can greatly extend the life of resources by wise use. In far too many instances no ultimate answer to the problems of depletion can be visualized. It is high time that the intelligent citizens of the world began thinking about the technological aspects of the future.

Make no mistake, I am not objecting to man's presence on the earth, or to his efforts to improve himself and his environment. I merely object to his digging himself into a hole that he can't get out of. I contend that if civilization continues it will be based on the widespread use of natural resources, and that when the resources are gone civilization is done. If we do not take technological steps to meet the depletion of tomorrow, we will find ourselves stifling at the bottom of an insurmountable wall before we know it. One of the social objectives of education should be to combat the insidious remark of Uncle Joe Cannon: "What has posterity ever done for us?"

THE PROBLEM OF CONSERVATION

Only recently have we begun to realize that the problem of conservation is the problem of everyone. And only recently have science and technology been able to hold out any hope for an ultimate solution of the problems of mineral and soil depletion. That hope is now a mere suggestion of a glimmer on the horizon of the future. It will never become a reality without a great deal of concerted human effort. Chemistry and physics will mean a great deal more to students if they can be brought to realize that the very existence of future civilizations depends upon man's mastery of these fields in which an enormous amount is still unknown.

IMMEDIATE SOCIO-TECHNOLOGIC PROBLEMS

There are many problems with technological backgrounds that are more immediate than that of depletion. A generation ago synthetic indigo, a product of a chemist's test tube work, replaced natural indigo in the world market. A million Hindus starved to death because there was no market for their natural product. That was bitter technological unemployment on a large scale. We are surrounded by technological unemployment, though not always on epidemic scale, despite the tendency of many industrialists and politicians to ignore it. It is an absurdity and an admission of defeat to say that the problem cannot be solved. Science and technology can help solve it; so can economics and sociology. Every citizen is vitally interested in the problem. Its consideration should be part of his education. Science and technology have greatly increased the real wealth of the world, but they have not spread the benefits with even hand and have often brought atrocious hardships. The social injustices can and must be corrected.

In 1898 Sir William Crookes predicted that the world would be starving by 1930, because the supply of natural nitrogen compounds for fertilizers would be exhausted. Chemists and technologists killed that bugaboo by devising means of making nitrogen compounds from the nitrogen of the air, so we are in no immediate danger of starving. But nitrogen compounds are also the basic material of high explosives. Now, any nation in the world with a little equipment, power, and technical knowledge can make an endless amount of high explosives. Future wars between well-balanced opponents bid fair to be almost endlessly destructive, simply because technology has made great advances. How much biological and material destruction can civilization withstand? No one knows the answer, but any person will appreciate the gravity of the situation more if he has some idea of the technical developments back of it.

Other technological advances which bring the possibilities of great benefit and also detriment to many are: a really satisfactory synthetic silk, announced by the Du Pont Company for commercial production in 1939; truly satisfactory synthetic rubber which may replace the natural product; the Rust cotton-picker which is almost on the verge

of rendering obsolete the hand labor of the southern Negro in the cotton fields. None of these have as yet stood the test of time, but there is a good chance that they will play significant roles in the future world economy. Can society adjust itself so that we may realize all the potential benefits without bringing misery to millions of others?

These few examples merely indicate how science and sociology are tied together. The implication is that sociology without physical science is an empty shell, and science without its social implications is narrow and probably dangerous.

EDUCATIONAL DANGERS

Presenting material based primarily on the physical sciences in a framework such as this has certain educational dangers. The author is one who is blissfully ignorant of the methods of secondary education and so can express opinions that are not burdened with too much knowledge of techniques. There is a real danger that the curriculum material which is embodied in that catchall "General Education" will be presented in such a sketchy manner as to be totally ineffective. Survey courses and projects can easily be spread too thin. Civilization will never be safe in the hands of dilettante scholars. The old lines of organization of human knowledge should not be thrown overboard until one is sure that there is something better on deck. It is my feeling that the newer methods of education will be most useful if they are used to enrich the old rather than to replace them completely.

Education must give some comprehension of the past, some knowledge of the present, and an appreciation of the possibilities of the future. It cannot disregard what has been or will be. Moreover, a democracy cannot long survive which does not equip all the citizens to meet their problems. In the past, all attention has been focused on the isolated scholar. The assumption is often made that if we now shift more attention to the average citizen, the scholar will suffer and perhaps be eliminated, to our detriment. There is that possibility, but there is nothing inherent in the educational process that says we must have one or the other. If we play our cards well, there is certainly no reason why we cannot have the average person educated for citizenship *and* the scholar, too; but if we are to have them both we can't lose many tricks.

We must recognize that modern society has the task of educating all the citizenry, with a liberal, broad background. In addition, there must be provision for the education of the specialist and the scholar. If we are careful we can do both jobs well, but if we treat our subjects too sketchily we may find that we are registering failure in both departments.

There is one intangible and insidious tendency in modern education which seems to be mentioned but seldom. There seems to me to be a real danger of carrying the emphasis on social implications too far. This is rank heresy and probably makes me a candidate for the stake. At least, it calls for justification. A great many educators, at least those who write in magazines and journals, discard as mere piffle any educational activity that is not focused on improving the welfare of the social group. The arguments have the flavor of excerpts from a communist catechism. It might be well to remind some persons that a man not only has to live with a group but he has to live with himself. After all, we are not a bunch of ants. If civilization comes to the state where each specimen of humanity cannot be an individual in his own right, as well as a member of the social group, then civilization has failed and we who educate may very well have helped to send it to limbo. Education in the past may have put too little emphasis on the sociological aspects, but there is indication that the pendulum may swing too far the other way in the future. If democracy means anything, it certainly implies that the dignity of man calls for his existence as an individual, not as a social automaton. If our education is to consist of nothing but pronouncements about the welfare of the group, then we are doomed to degeneration into a marching horde under the shadow of the man on horseback. However great our enthusiasm for advances in education, we need most of all to maintain a sense of proportion.

Scientific Method

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THE rapid extension of science teaching which began to take place at the opening of this century reflected a recognition—albeit a belated one—of the part that science was playing in the transformation of the world. Prominent among the influences that led to the extension of science teaching was an increasing demand for trained scientists in industry. In view of this, parents as well as employers were eager to see science promoted to a more important position in the curriculum. But it was not only on vocational grounds that a greater provision of scientific education was encouraged. There was a widespread recognition among all concerned with education that a knowledge of science was an important part of the equipment of the citizen of the modern world. Nor was it only scientific knowledge that was recognized as important. Leaders in educational policy saw that a more scientific attitude toward problems of all kinds was not only a condition of satisfactory individual adjustment to the modern world but also a condition of making democracy more effective.

DIFFUSION OF SCIENTIFIC ATTITUDES

The influence of science teaching has already been considerable and has been reinforced by people learning to adjust themselves to an environment in which machinery and quantitative measures have come to play an increasingly important part, and in which they are confronted by new and diverse social problems. This shows itself, not only in the great competence which a large part of the population has learned to show toward mechanical devices of all kinds, but also in the develop-

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ment of a more rational attitude toward a number of important social problems which, in the past, were regarded as improper subjects for examination.

In spite of the very considerable diffusion of scientific attitudes there are, however, very strong grounds for supposing that the schools have not played as large a part in the encouragement of scientific attitudes as they might have done. The conception of science that was adopted in most early science teaching was that which had developed among specialists—especially among specialists in the physical sciences—who were, for the most part, but little concerned with the social consequences of their discoveries. In the schools the physical sciences had a long lead over biological science and tended to suggest that all science must conform to their pattern. It is only recently that social processes and human behavior have been recognized as amenable to scientific study, or that attempts have been made to bring out the universal applicability of scientific methods to problems of all kinds.

The emphasis on the physical sciences was the result partly of the very general admiration for the technological achievements these sciences had made possible and partly of the greater number of openings that offered themselves for young people trained in them. It arose also from the introduction of science into a system of education which still valued subjects chiefly for the contribution they were thought to be capable of making to mental training. The physical sciences with their highly systematized bodies of theory seemed to have a much more powerful claim for inclusion in the curriculum than the biological sciences. The challenge the biological sciences brought to many established beliefs and taboos was an additional reason for delaying their introduction into the curriculum.

Of recent years, the educational value of school subjects has come increasingly to be judged by criteria other than those of their disciplinary values. With the rapid increase in the school population during recent years and with the admission to high schools of an increasing population of young people who were not concerned with science as prospective specialists, there have been far-reaching changes in science teaching. In particular, a great deal has been done to give science teaching a more practical bearing, to show the application of scientific principles to prob-

lems of all kinds, and to encourage students' initiative in scientific criticism and inquiry.

But in spite of these changes, the influence of the earlier traditions is still strong. There is still relatively little correlation between the various sciences. What "belongs" to physics is still often regarded as quite separate and distinct from what "belongs" to biology, while there is as yet very little recognition of the similarities between the methods pursued in these and in all other sciences. In a great deal of science teaching great emphasis is put on the mastery of formulations of theoretical principles before students have gained sufficient practical experience of the materials and processes upon which they are based. At the same time very little is done to make young people aware of the methodological problems—such as those of classification of measurement, of defining descriptive terms and units of measurement—upon which the progress of all science depends. Many young people complete courses in science with only a very slight recognition of the way in which the advance of the sciences they have studied depends upon the unambiguous formulation and communication of principles.

In the past, when faith in the transfer of training was much stronger than it is today, it was assumed that the influence of science teaching would inevitably show itself in the acquirement by young people of a more scientific attitude in approaching practical problems of all kinds. The error of this assumption has been strikingly illustrated by the totally unscientific way in which many men who have made important contributions to specialized sciences approach questions which lie outside their particular fields. Psychological studies have, moreover, shown that the influence of scientific training is likely to become general only when the principles upon which scientific judgments are made are themselves consciously recognized, and are consciously applied to new problems.

As things stand today, science teaching has still much to contribute toward making young people appreciate the applicability of scientific methods to the investigation of all questions of fact, including those which arise in connection with sociological and psychological problems. The more it can contribute in these ways, the more it will be helpful to people and the greater will be its contribution to making democracy effective.

THE PRACTICAL ROLE OF SCIENCE

The Bureau of Educational Research in Science at Teachers College has been concerned with making suggestions as to how science teaching could be so conducted as to give young people a more coherent picture of the world as conceived by science and to help them to see themselves more clearly as part of that world. It has also been concerned with encouraging a recognition of the part that science has played and is playing in the transformation of the world in which they are living, and a better and more conscious command of scientific method.

My own responsibility has been to prepare a report which would make clear the methodological principles inherent in all scientific inquiry and how these principles are adapted to particular kinds of problems. It has also been to show how questions of fact are related to questions of value and how the kinds of criticism and judgment characteristic of science can be brought to bear on problems of all kinds. I have sought to suggest methods whereby the programs of science teaching recommended by other members of the Bureau may be conducted in ways which would give young people a clear sense of the methods by which particular conclusions have been arrived at, as well as some practice in applying those methods to other problems. I have also sought to examine the general problem of bringing the various subjects that make up the science curriculum into closer relation, not only with one another, but with all the other subjects that have a place in the curriculum.

LINGUISTIC INSTRUMENTS AND TECHNIQUES

It has seemed to me that most science teachers have a very good appreciation of the experimental instruments and techniques upon which the advance of science depends. They are, for example, very well aware of the processes through which the similarities on which general principles are based, are recognized. They are also, for the most part, well aware of the experimental processes whereby hypotheses are tested. As a rule, however, they have a much less complete understanding of the linguistic instruments and techniques upon which the advance of science depends as much. Many are quite surprised when they are reminded that the conclusions at which the research worker in science is aiming are

always *statements* expressed in words or other symbols. In view of this it seems important to emphasize how the advance of science depends upon establishing unambiguous relationships between symbols and the events and processes which they serve to describe. It seems no less important to point out the great opportunity science teaching provides for giving young people a conscious understanding of the problem of bringing symbols and especially words into such unambiguous relationships. Through the help of science teaching in which these aspects of science are made clear, young people may be made much more aware of the way in which confusions arising from language may prevent their getting to grips with practical problems, especially with social or psychological problems where these confusions are especially liable to creep in. Through such teaching, young people may also be helped to become aware of—and so proof against—efforts of propagandists of various kinds to mislead them. For this it is important that they should recognize that in passing from the school to the world they are passing from an environment where they are subject to the influence of teachers whose concern is not to mislead them but to insure that they are truly informed, into a world where there are many who, out of self-interest, are concerned with influencing them to adopt particular courses of action, whether or not they would act in those ways if they were more fully informed and were not subject to emotional appeals. As soon as science teaching succeeds in bringing young people to recognize the part that authority plays in the advance of science and the ways in which authority may be abused, they will learn to ask of all authority such questions as: "What exactly is it that is being asserted by this paper or speaker?", "What authority has the author of these statements?", "What interests or motives may be activating him in making them?", "How can I verify what he is saying?", "How does it correspond with what I already have good grounds for believing?", "What conclusions follow if it is true?" The habit of asking such questions should be encouraged for it would have a very great contribution to make to democracy.

METHODOLOGICAL PROBLEMS

In addition to a discussion of scientific method as it can be applied to all questions of fact, I have concerned myself with the methodological

problems that the members of the Bureau are attacking in attempting to "relate the materials from the different sciences." If we ask how the "material" from the subject of botany and "material" from the subject of zoology are to be related, an ambiguity at once appears. Are we asking how the *things* studied by botany, i.e., plants, are related to the *things* studied by zoology, i.e., animals; or are we asking how the *body* of knowledge (inscribed or remembered) which has resulted from botanical studies is related to the corresponding *body* of knowledge which has resulted from zoological studies? This is rather like asking whether the school boy in studying geography is studying the earth or is studying a "subject." In this context the word "subject" refers primarily to an inscribed body of knowledge—usually restricted by the particular textbook the student is using. Most teaching leaves students with the impression that it is the latter, hence the frequency of the idiom, "We have *done* South America: now we are going to *do* Australia." This shows how easily a body of inscribed knowledge is confused with that to which it refers and from which it was derived. The same confusion shows itself in the way the phrase, "the subject of study," is interchangeable with the phrase, "the object of study." The *subject* of students' study is too often no more than the verbal product of other people's study. The product of other people's study is too rarely recognized as being valuable only as a *means* of coming more readily and fully to understand the *objects* which they were studying.

The bodies of knowledge built up by botanists and zoologists are distinguished by the fact that biologists and zoologists have different interests and *restrict* their studies from the outset in different ways. The difference is based upon the fact that plants and animals fall "naturally" into two fairly distinct classes; and though these may not be so sharply distinct as the "natural" distinction which the chemist recognizes between the chemical elements, it is no less sharp than the distinction which separates organic from inorganic chemistry. Both the botanist and the zoologist proceed with their studies *after* implicitly accepting a definition of their subject and accepting that as a limitation of their interests and study. The botanist, of course, takes note of such things as the part insects play in fertilization of flowering plants, while the zoologist takes note of the fact that the source of many insects' food

is nectar. Such considerations are, however, of secondary importance. Neither the specialist in botany or zoology will, as such, concern himself with the dynamic interrelation of plants and animals. The bodies of knowledge which each builds up will contain but little reference to such interrelationships.

THE "MATERIALS" OF THE SUBJECTS

There are two ways in which the material of the two subjects may be related and these correspond to the two senses in which the word "material" may be understood. The "materials" of the two "subjects," *interpreted to mean the two bodies of doctrine*, may be related by finding common references and resemblances between the patterns of knowledge built up by each. Both botanist and zoologist are studying things which grow, which reproduce themselves, and which have the other characteristics which entitle objects to be called "living." This gives the bodies of knowledge they build some common characters. The plant and animal physiologists are, moreover, concerned with the chemistry of the particular living things they study, and this provides further common ground. In general it may be said that attempts to relate the "materials" of the two "subjects," taking that to mean *the two bodies of doctrine*, consist primarily in discovering common principles, and in relating them within a wider scheme of generalization. Much the same can be said of the correlation of such sciences, as the traditional "heat, light, and sound," "electricity and magnetism." Here the unifying principles are those of mechanics, and such principles as temperature, atom, molecule, energy, potential, and wave motion.

The "materials" of the subjects, botany and zoology, may, however, be taken to refer *not* to the two bodies of knowledge built up by people with specifically defined, but different, interests, but to the *materials* in the sense of the living things studied by botanists and zoologists. To relate the "materials" in this sense can be done only by instituting studies which have an aim different from the earlier aims either of botanists or of zoologists. It is necessary to study the interaction of plants and animals either as they take place under the conditions of controlled laboratory experiment, or as they take place "in nature." Such a study becomes an *ecological* one, and may be defined either narrowly or

broadly. It may cover the interaction of a limited number of plants and animals in a habitat, the conditions of which are controlled, or it may study the interaction of plants and animals in a natural habitat in which the observer "interferes" as little as possible. Much the same may be said of relating the materials studied under the headings of heat, light, sound, electricity, and magnetism, though here the historical development of those separate sciences has done much more to discover such material relations than was the case with biology and zoology.

Exactly the same problem arises in the attempt to "bring together" or to "relate" the "material" which exists (e.g., in the "archives") under such headings as History, Geography, Physics, Social Science, and Literature. Here the same ambiguity and danger of confusion arise over the word "material" as did in the previous biological example. Certain relationships can be discovered between the "materials" of science, and the "materials" of literature. For example, scientific ideas are to be found expressed in literature, and have parallels in some kinds of literary criticism. But the discovery of such relationships does not reveal the processes from which they arise any more than a recognition of similarities between a number of different plants reveals the evolutionary processes to which they are due, or the dynamical ecological relationships in which the plants themselves stand to one another and to all the other living things within the changing conditions of their environment.

For general education we must concern ourselves primarily with bringing together the "materials" of the different subjects by returning to the actual things which the subjects describe and studying them in relationships that were not of interest to the specialists who developed these subjects. In this we must adopt an attitude which differs from that of specialist educators of the past rather as the attitude of the modern ecologist differs from that of the old-fashioned biologist or zoologist. The physicist, for example, must learn to recognize the ways in which the materials he studies, as well as the theories developed by physicists, enter into human affairs. The student of literature must correspondingly give up his narrow academic conception of literature, and consider not only the part which "literature," in the specialized sense, plays in human affairs, but the part that is played by writing of all kinds.

In the past students of literature have devoted themselves almost ex-

clusively to the study of works which they selected because of their literary "excellence" (which at this point we need not stop to define) and because they had an especial power of illuminating people's minds about themselves as well as about their relation to one another. Moreover, students of literature were not primarily interested in the part such works played in maintaining and preserving social traditions or in communicating the discoveries of one generation to others. They also disdained to study ephemeral writing, however great its social influence. Though there has been, of recent years, a growing interest in the way great authors reflect the habits, problems, and ideals of their times, little has been done to study the *effects* of literature, or rather the part played by literature in the social *process*. Insofar as this has been done the study has been made ineffective by the retention of the very narrow definition of literature developed by scholars who did not concern themselves with a study of more utilitarian kinds of writing, or writing aimed at diverting the less educated. Literature defined in this way leaves entirely out of account that vast quantity of printed material that today has such enormous circulation and which, whatever may be said about its literary merit—or lack of merit—, certainly plays no less a part in the social process than literature in its narrower and more refined sense. For general education this narrow definition of literature must be broadened as must also that of other subjects. Thus science teaching must include references to scientific and technical literature, as well as to the literary means whereby scientific ideas are popularized and come to play a part in public opinion. Similarly English teaching must recognize Bacon's essays and the Bible, as well as bill boards and broadcasting, as having a bearing on "science." As subjects are broadened they will increasingly overlap, while their boundaries become increasingly indefinite. Reforms along such lines were suggested by Professor Whitehead when he expressed the following point of view:

> Traditional educational methods are far too much occupied with intellectual analysis and with the acquirement of formularized information. We neglect to strengthen habits of concrete appreciation of the individual facts in their full play of emergent values, and emphasize abstract formulations which ignore this aspect of the interplay of diverse values. . . . The Middle Ages had an ideal of rationalism, but they failed in its pursuit. For they

neglected to note that the methodology of reasoning requires the limitations involved in the abstract. Accordingly, the true rationalism must always transcend itself by recurrence to the concrete in search of inspiration. A self-satisfied rationalism is in effect a form of anti-rationalism. It means an arbitrary halt at a particular set of abstractions.[1]

As we come to conceive of subjects more broadly they will increasingly overlap while their boundaries will become less distinct. This will make an end of any discussion of *exactly* what should be regarded as falling within a particular subject. Thus physics, as more broadly conceived in the interests of general education, will help to illumine young people's understanding, not only of their physical environment, but also of their social environment as scientific technology and scientific ideas have influenced them.

We cannot, of course, hope to discover the relationship of everything to everything else. There must be some principle of selection. In the past the selection has been made largely according to the interests of specialists who have been concerned with building up systematic patterns of rational knowledge, of which the sciences provide the outstanding examples. Knowledge built up on this principle of selection has had an enormous influence in extending our control of nature, but has not contributed much to our understanding of the social processes in which all human knowledge, as well as all human achievement, has its roots. Training in the methodologies of special subjects has, moreover, had the effect of hindering our understanding of these very processes. For general education we must seek a corrective in adopting a new principle of selection. This must be such as will emphasize these relationships which will contribute most to our understanding of the social processes in which every citizen has a part to play, a responsibility to accept, and ideals to discover and work for.

UNDERSTANDING THE SOCIAL PROCESS

A final question that we may ask is how this general understanding of the social process is to be given to students. Here we must rely on the interpretative power of their minds. The picture which a student

[1] Whitehead, A. N. *Science and the Modern World*, pp. 284, 288-289. Lowell Lectures, 1925. The Macmillan Company, New York, 1927.

acquires must result from his applying his mind to the experience and instruction provided by his environment and by his teachers. His knowledge of the vast interrelations of things within the social process must come from a mental synthesis acting on separate items of knowledge. The task of the teacher must be to recognize what knowledge has to be provided to make it possible for the student to make a synthesis which will enable him to understand the world in which he is living to the fullest extent that his powers allow.

For a teacher to be able to succeed in this he must, himself, have a wide background of general knowledge. He must have learned to conceive of his subject broadly, and to see it in its historical perspective. Most academic courses, as now planned, do not give prospective teachers the general knowledge necessary for this, nor do they direct their interests toward acquiring it through their own reading and inquiry. Those whose interests develop in these directions do so in spite, rather than through the help, of academic influences. It is true that a number of colleges have introduced reforms whose purpose is to qualify students more effectively for serving the cause of general education in the schools, but further developments in these directions are much to be desired.

To build up the general knowledge, the interests, and skills that are necessary for general education, courses may be planned under the headings of the traditional subjects. But under many conditions it might be expedient to abandon these and to carry on instruction planned under other headings, such as "personal life," "home life," "social and civic life." A variety of such approaches to general education can be conceived of, and any particular choice would have to depend upon particular circumstances. Some courses might seek to emphasize some particular relationships and to work out some parts of the general pattern in greater detail than others. But whatever plan of courses was adopted, teachers would have to bear in mind that their aim must be to build up a unified picture of the social process in which the interrelationships of the things studied under different headings came increasingly to be recognized.

In a society whose complexity was much less than ours, and in which specialized knowledge had neither advanced so far, nor come to play so important a part in the development of the social structure, the relation-

ships of such specialized instruction as was given, to the whole social process would at once become apparent without any effort having to be made by the teacher. But in our society where these relationships are very much less apparent, he must recognize his responsibility in demonstrating them, and in giving his students as clear an understanding of the social process as possible. He cannot, of course, bring his students to know this in more than broad outline. Nevertheless, that outline must be provided in a way which will make it possible for what is subsequently learned to be fitted into it.

The picture which the teacher has to build up is not a static one, nor is the attitude adopted toward it primarily receptive. It is of the utmost importance that teachers and students should recognize their knowledge as having its origin in a process which is in essence a *social* process, and as also referring back to that same process. They must also recognize that the extension and application of their knowledge, while depending upon their individual capacities and contributing to their effectiveness as men and as citizens, are also parts of that same process.

The Physical Sciences and General Education

By DUANE ROLLER

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AS has been pointed out,[1] the persistent demands being made today on the science program for the general student are the result mainly of a changing psychology, an increasing and changing school and college population, the impacts the sciences are making on human living, and a dawning recognition of the need for a new conception of the functions of education for living in a modern, democratic society. The implications for the physical science program, and some ways in which they can be realized, are discussed in the present article.

The public is well aware of the extent to which technologic advances having their origins in the physical sciences have profoundly affected our culture in its material aspects, and of the dire need for finding the best ways to utilize these advances for the common good of mankind. The more obvious advances, involving alterations in our industrial and living conditions, have been widely discussed; and, despite the bewilderment resulting from the many problems raised, the recognition is general that the physical sciences have contributed markedly to an increase in standards of living and have placed at our disposal countless devices for making life more comfortable, more enjoyable, and safer.

But the rapid shift now taking place in our culture, caused by these sciences, is still more fundamental than this. It involves our patterns of thinking and values as these have been affected by a changing and enlarging picture of the physical world, and of man's place therein. Ideas and concepts radically new in character have long been emerging from the physical sciences, and the extent to which they are often in serious

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[1] S. R. Powers, "Improvement of Science Teaching," pages 273-283, this issue.

conflict with conventional beliefs of pre-scientific origin is not generally understood or appreciated. Large and important areas, even in the sciences themselves, have scarcely been touched by the shifting pattern of thinking that is emerging from modern physics. The physical sciences, moreover, possess almost countless tested methods and technics by which a large variety of human problems can be attacked with confidence and efficiency, and it is highly probable that these procedures, or modifications of them, will play a fundamental role in the future solution of many of the crucial problems of living. Yet one does not have to look far under the surface in our so-called "age of science" to realize that scientific procedures still play an insignificant role in settling the problems either of the individual or of his social organizations. As individuals we are not so much scientific as we are mere button-pushers and users of the products of science. Socio-economically—in systems of production, in government—we are anything but scientific. The fact is that society and the individual actually are receiving infinitely less than the sciences have to give them.

FORMULATION OF CONCEPTS AND PROCEDURES

As educators our task is not only to inculcate the emerging concepts and procedures that are to dominate our new culture, but in many cases actually first to formulate them; that is, to interpret their human meanings and emotional significances. To the archives of the modern sciences we must look for the basic conceptions that will contribute to a world view free from major paradoxes: for an enormously increased time perspective; for understandings that are contingent and approximate, and involving processes functional and evolutionary; for tests and safeguards of valid and creative thought. It is not implied that human and social problems are thereby to be handled solely by the objective and detached methods of the sciences, and that they will thereby necessarily cease to be *value* problems. It is for the *basic* ideas and beliefs that we must go mainly to these sciences whose advances are responsible for the disintegration of the older cultural framework. The latter was the product of the best available knowledge, investigation, and speculation of its pre-scientific time; and it seems apparent that the basic modern conceptions, which we are to render meaningful and con-

gruent, must likewise be drawn from and supported by the best scientific research of our present age.[2]

To make a thoroughgoing and truly comprehensive formulation of the educational material already implicit in the sciences would be a task of encyclopedic character—a task demanding breadth of knowledge, insight, imagination, and a degree of scholarly performance comparable to that exhibited by the philosophers of ancient Greece when they made that magnificent formulation of the knowledge which had accumulated up to their time. The Greek synthesis necessarily was pre-scientific in character and now is largely obsolete; but it was carried out with such great perspective and insight that it provided the basic ideas and conceptions of our Western European culture, a culture which only in our own time is at last reaching the end of its cumulative disintegration. Eventually we will have a formulation of modern knowledge comparable in its pretentiousness and usefulness to the earlier one of the Greeks—provided only that civilization can survive its advent. In the meantime, the exigencies of our time demand that we do what we can, no matter how modest the attempt may be, to supply a few of the elements leading to such a formulation. Here we take a lesson from the sciences themselves; we have learned not to wait for, or even to expect, so-called ultimate, perfect schemes and panaceas. Recognizing the enormous complexity of the culture which is arising, we must seek for partial and tentative formulations that will help us a little on our way.

An obvious beginning is to search the archives of definite areas of the sciences for material that appears to be relatively amenable to interpretation, and this the present author has done in the case of several promising areas in the physical sciences. The material has been assembled[3] under the following chapter headings:

I. The Background of Physical Science for the Interpretation of Educational Issues
II. Machines—The Role of Mathematics in the Solution of Physical Problems

[2] See L. K. Frank, *Social Frontier*, Vol. 3, pp. 171-173, March, 1937; pp. 209-211, April, 1937; D. Roller, "The Role of the Sciences in General Education," *The American Physics Teacher*, Vol. 6, pp. 244-253, October, 1938.

[3] In a monograph now being prepared for publication.

III. Motion and Its Changes—The Mechanics of Galileo and Newton—The Astronomical World Picture
IV. Engines—The Evolution of Human Ideas Concerning Work, Energy, and Power
V. Our Developing Conceptions of the Composition and Structure of Matter

In the selection of material to be included in these chapters, a main guide has been the kinds of changes that it seems desirable for young people to undergo if they are to be equipped to face modern situations and problems. Thus the areas listed were scanned for material convertible to the purpose of developing in the individual: abilities and traits, such as careful and critical methods of thinking; attitudes, appreciations, standards of conduct, and creative activities that have proved their worth in these sciences and that bear promise of being of general value; continuing interests in those aspects of culture and activity thought to be of unusual importance in our present civilization; and deep insights into nature based on the major generalizations of the sciences themselves. If the educational material thus assembled is scientifically and historically sound, it will serve inherently to correct some of the shortcomings[4] in present-day teaching practices; that is, it cannot help but provide a better correlation of the sciences, a clearer picture of the interplay of facts and theory based on rich student experiences with actual physical phenomena, and an increased appreciation of the wide range of applicability of scientific procedures. Moreover, if the material is at all comprehensive, it will certainly trace the histories of important concepts and ideas, picture scientific advances in their correct cultural and philosophic setting, and, most important, uncover the interplays of scientific and socio-economic developments.

Although no single topic taken from any field of knowledge is likely to contribute to all educational objectives, *the amount of material yielded by any major scientific topic turns out to be amazingly large and holds great promise when placed in the hands of a teacher who is experienced, resourceful, and thoroughly sensitive to the objectives of general education and the character of our modern culture.*

The following condensed version of a part of the writer's Chapter IV

[4] Powers, *op. cit.*

may serve to illustrate the general character of the material assembled. It must be emphasized that this excerpt is condensed; many of the more purely scientific details appearing in the original chapter are omitted, since the general trend of the treatment can be illustrated without them.

The Evolution of Human Ideas Concerning Work, Energy, and Power

(A condensed version of the first third of Chapter IV)

Every living thing must have food, which serves, among other things, to supply it with heat and with the means whereby to be active. Certain internal activities are essential for life, as are also certain external activities, such as those involved in the search for food, and protection from the elements and the attacks of other living things. That beasts of burden can be gotten to perform many of their external activities for them was learned very early by some animals, especially man. Primitive man also made the important discovery that it is possible to get some of this labor done by methods which do not involve appreciable muscular effort. To supplement his beasts of burden, he gradually devised wheels and boats that were driven by the wind and running water. He came thus to utilize driving forces that ordinarily are wasted or that can be destructive. Such mechanical labor has the advantage of being tireless and comparatively rapid; it is likely to be dangerous only if it destroys more than it produces, or hinders men from engaging in desirable intellectual activities.

The wind and running water unfortunately are not always or everywhere available. What was needed was more dependable mechanical labor and more ways to utilize it. Moreover, windmills, water wheels, and sailboats are not transforming devices; their *motions* are derived directly from the *motions* of wind and water. The need was for transforming devices which, like the body of an animal, would utilize fuel to produce motion, or, like the leaf of a plant, would utilize sunlight in producing food. Any such transforming device may be called an *engine*.

In nature there are, by this definition, many engines—volcanos, the leaf of a plant, the metabolic system and also the eyes and ears of an animal; and there are many transformation processes—the sunlight heating the soil or tanning the skin, fuel burning to yield heat or light or to cook food. But for primitive man to have been able to recognize the essential and common character of these various natural processes would have been tantamount to having possession of concepts which slowly emerged into human consciousness and which in fact were never fully developed until modern time. Moreover, there was not much incentive to search for labor-saving devices as long as human and animal labor was cheap and time was plentiful.

The first man-made engines, such as those of Hero of Alexander, con-

sequently were developed mainly as toys. During the Dark Ages even these various contrivances seem to have been lost to sight, and some fifteen centuries elapsed before the ideas involved in them were revived. The forerunners of modern steam turbines of both the reaction and impulse types were at hand, but there was little incentive or attempt to develop them on a large enough scale to save human labor. One invention of the Middle Ages—guns employing gunpowder—had obvious large-scale possibilities, and indeed led to the celebrated and fertile study of the motion of projectiles made by Galileo and his followers (Chap. III). But engines utilizing various explosive agents to operate machinery were not suggested until the eighteenth century, and another century and a half passed before the idea was carried out. Such engines were found to require expensive fuel; hence efforts to develop them were abandoned for a time, particularly since the possibility of using steam as the working agent was then attracting wide attention.

That steam condensing in a closed chamber produces a partial vacuum had been known for at least a hundred years before it was applied in the invention of a condensation pump, at a time (1698) when fast pumps were badly needed in flooded coal mines in England. Since this pump had no piston or other moving parts, it could not be used to run machinery. The first commercially important engine having a moving piston was the famous Newcomen engine (1705), which was also used to operate mine pumps. The valves of this engine were operated by hand, and a boy hired for the job is said to have hit upon the idea of saving himself labor by rigging up a contraption whereby the engine itself operated the valves. This device at once ended the need for valve boys and supplied the forerunner of the automatic valves now in use on all engines.

Dozens of Newcomen engines were in use in the English mines and potteries after the middle of the eighteenth century. But this engine was not well adapted for producing rotary motion, which was needed especially in factories, and it was slow and very inefficient in the use of steam. Its wastefulness caught the attention of a young instrument maker at the University of Glasgow—James Watt—who surmised the reason but was unable to test his idea because certain prerequisite knowledge regarding the properties of steam was not then available. Watt also observed to his astonishment that a pound of steam upon condensing in the engine yielded enough heat to raise about six pounds of cold water to the boiling temperature. Failing to understand the reason for this remarkable fact he consulted Joseph Black, at the University, who knew more about the subject of heat than any living man. Black then explained to Watt his own investigations on heat which he had been carrying on and lecturing about for some time.

The basic phenomenon observed in connection with heat is that various objects differ in their degree of hotness and coldness, or temperature. As

time progressed, it was found much better to determine temperatures objectively and quantitatively with the aid of thermometers; nevertheless, hotness and coldness can be observed directly through our temperature senses. On the other hand, the idea that something called *heat* passes between bodies of changing temperature is of the character of a hypothesis. No one has ever observed heat, as such, but only various effects that are attributed to heat. Clearly it cannot be temperature itself that is transferred from a fire to water when the latter is heated; for do we not observe that different quantities of water in a teakettle placed for the same time over the same fire acquire quite different temperatures? Something we call heat is inferred to have entered the water. Thus heat is distinct from temperature, although the two are related as cause and effect.

So far as our observations with the teakettle are concerned, the only property we need to assume for heat is that it produces a rise or fall of temperature when it enters or leaves an object. Nevertheless, we should like to be able to explain what heat is—to describe it in terms of phenomena with which we feel more familiar. In Black's time, it was regarded as some kind of "substance." This was a natural and reasonable assumption so far as the evidence then at hand was concerned.

As we frequently have had occasion to note, a physical concept is of little use unless its definition is quantitative, as well as objective and operational, in character. Of interest, therefore, is the fact that a way to measure heat could be specified at a time when nothing was known about heat other than that it was the inferred cause of temperature changes in objects. The unit of measurement adopted was the quantity of heat that must be imparted to a specified mass of a particular substance, say water, in order to produce a specified change in its temperature. It should be noted that this definition is useful only if it can be asserted that equal quantities of heat produce exactly the same temperature changes in equal masses of water. This assertion cannot be tested experimentally unless we can agree on what is meant by "equal quantities of heat." A way out of the difficulty is to convert the assertion into an axiom, regarding it as growing out of the general axiom that nature is uniform. Then the assertion itself can be regarded as the *definition* of "equal quantities of heat"; equal quantities of heat are such amounts as will produce exactly the same temperature changes in equal masses of water.

Black not only was the first to draw the sharp distinction between temperature and heat which we have already mentioned but, in his work on the capacities of bodies to absorb heat under various conditions, made the important discovery that equal masses of different substances possess different "capacities" for heat. Thus rose the need for a new physical quantity, the *thermal capacity of a substance.*

The discovery of Black's that most interested Watt, however, was the

conception of "latent heat." The general conception up to Black's time was that any substance to which heat was being applied always rose in temperature continuously. Black showed, however, that while ice is melting, it maintains, if well stirred, a perfectly constant temperature. This is true of the melting of many solids and also of the boiling of any liquid. Moreover, the amounts of heat that must be supplied during melting or boiling are relatively large. To be able to express these amounts quantitatively, it was found useful and economical of thought to invent the quantities now called *heat of fusion* and *heat of vaporization.*

Although the concept of heat came into being as the inferred cause of observed temperature changes, we have here cases of heat apparently being supplied to objects during melting and boiling but without causing any change of temperature. The heat absorbed from the fire appeared to become "latent" in the substance, although it was found to be recoverable in the reversed processes of freezing and condensation. To meet these observations the additional assumption was made that, during melting, say, the heat and the solid formed a kind of chemical compound—namely, the liquid—and that the heat when thus combined could not produce a rise in temperature. Other properties were gradually ascribed as new facts accumulated; for instance, that heat was indestructible, weightless, and elastic. The observation that matter usually expands when heated was accounted for by assuming that heat was self-repellent but attracted by matter; thus an object which heat entered was driven farther apart.

During Black's lifetime his great discoveries remained unpublished, for heavy duties, ill health, lack of initiative, and an almost morbid horror of hasty generalization prevented him from going further than writing out his findings in the form of lecture notes. Indeed, his work might have remained long unappreciated had it not been for Watt's work on the steam engine, on which Black's work had so much influence. Thus we have another illustration of the interplay between scientific and technologic advances.

Watt now saw more clearly than ever the desirability of decreasing the wastefulness of the Newcomen engine, for fuel would be saved and this would help insure the wide use of these engines for driving machinery. He added flues to the engine boiler to increase its heating surface, encased the boiler and engine parts with a poor heat conductor, such as wood, and made other similar modifications. Later he saw that none of the steps were really fundamental; the cause of the wastefulness of the Newcomen engine was inherent in its design.

The major improvements eventually made by Watt in the light of Black's teaching were epoch-making in character, and finally led to the condensing engine, patented by Watt in 1769. Other improvements, which he made

later and patented, increased enormously the efficiency of engine operation.[5] Indeed, the ordinary steam engine of today differs from that finally developed by Watt mainly in mechanical details. A modern advance has been in technics of machine construction, the lack of which had hampered Watt.

The demand for Watt's improved engine came first from the English potteries and mines, and later from the textile industry which by that time had undergone mechanization. Canals were being dug to transport pottery and an expanding volume of other commodities, and on one of them the first steamboat was launched, in 1802. At the mines iron rails had been laid for the horse-drawn trucks with their heavy loads, and here at the mines, where steam power had so long been in use, the first steam locomotive was tried out, in 1804.

Because the duration of his basic patents was extended by acts of Parliament, the firm of which Watt was a partner had a monopoly on the steam engine until near the beginning of the nineteenth century. The firm was conservative and opposed certain improvements. . . .

The next section of this same chapter deals with the evolution of the concepts of work, kinetic and potential energy, and power. Finally, in the last third of the chapter, the concept of heat reappears, now in its modern form, and there follows the principle of conservation of energy, the work of Carnot, thermodynamics, widening conceptions of possible forms and sources of energy, modern engines, and modern conceptions of the interrelation of matter and energy.

To turn now to Chapter III, the character of the material there assembled will be illustrated, not by an excerpt, but by listing the "generalized insights," or interpretative generalizations, that appear to emerge from the first section of the chapter. This section, which deals with Galileo's principle of inertia, constitutes about one fifth of the chapter.

Possible Generalized Insights

(from Chapter III, first section)

1. Our inheritance of accumulating scientific facts, tools, concepts, and methods clearly enables us to meet problems and situations today that could not be met by past generations of people who had comparable native ability but who lacked this scientific inheritance.

[5] The details of the main steps in the development of Watt's engine are exceedingly instructive, for they not only afford understanding of many important heat phenomena but throw light on the general way in which a major technologic development occurs.

2. Galileo's work is seen to illustrate peculiarly the great advantage—now realized in all the sciences—of first framing the pertinent questions concerning a new phenomenon, and then planning experiments for answering these questions that will be as crucial in character as possible; thus the amount of experimentation is minimized and much futile action is saved.

3. Most physical investigations of far-reaching character have had their origin in specific, relatively simple, and timely problems, which were treated with quantitative exactness, rather than in deductions made from general philosophic schemes or *a priori* principles.

4. Any branch of science is "exact" only in the sense that it is *relatively* accurate and precise; it is as exact as it needs to be in order to deal with the problems for which it is designed.

5. Galileo's investigations were greatly facilitated by his invention of the concept of acceleration.

6. Experience shows that if a physical concept is defined operationally, it need be only extended, and not discarded or even fundamentally revised, when new discoveries are made.

7. From the operational point of view, the way to make sure of the meaning of anything is to analyze what we do and recognize the activity involved; and the way to determine whether a particular question has meaning is to find whether it is possible to specify operations by which an answer to the question may be given.

8. It appears that many troublesome social, economic, and ethical questions could be greatly clarified if the operational point of view were adopted with respect to them.

9. According to the principle of inertia, a body will move with constant velocity as long as the total external force acting on it is zero.

10. In arriving at the principle of inertia, Galileo made use of the idea that if one explanation holds in a certain case, it is unlikely that a quite different one will hold in some case only slightly different; this is the hypothesis of continuity, which we unconsciously use whenever we fill out the gaps in everyday experience with the help of ideas that experience has suggested.

11. We unconsciously employ hypotheses in all of our thinking, and yet it can be shown that many of them are invalid in particular circumstances.

12. The principle of inertia is seen to be an axiom, not a law; every science is built on axioms.

13. One way to solve a perplexing problem is to convert it into an axiom.

14. The principle of inertia provides a qualitative definition of force.

15. Endless arguments have been avoided by abiding by the rule that each important word employed in a discussion be defined as precisely as possible, and that its meaning be thus restricted during the discussion.

16. Although the most progress is made when anthropomorphism is avoided, to eliminate it completely appears to be impossible; the sciences are made by human beings, who can do no more than try to be as impersonal and objective as possible in making their observations and framing their descriptions of nature.

17. In a science in which the definitions are extremely precise, several different names may exist for exactly the same quantity; this is in contrast to the poverty of language in general, where the trouble is not with too many words having one meaning, but with too many meanings for one word.

18. A map is *not* the territory, nor does it represent *all* the territory.

19. The mechanical theory of Galileo and Newton is seen to repay careful study, not only because of the light it throws on the character of physical theories in general, but because its concepts and methods have permeated and helped shape all the sciences, and also have had enormous influence on general thought and outlooks.

Generalizations similar in number but varying widely in character could be drawn from the remaining four sections of this chapter, and from the other chapters as well; for example, from the condensed excerpt of part of Chapter IV which appears earlier in this article. It must be emphasized that these generalizations when separated from the material from which they are drawn have little educational significance. It is only when generalizations emerge in the minds of young people as a result of thorough study of the original material, including experience with the phenomena involved and practice in the use of the material in the pursuit of real problems, that any appreciable modifications of student behavior can be expected.

A possible initial test of the educational worth of the material is provided when it is demonstrated whether teachers who understand the character of our modern culture and who are sensitive to the objectives of general education can formulate from it a large number of generalized insights that are acceptable to them. Of course, the next test is whether proper methods of evaluation show that the material can be used effectively to help foster the abilities, traits, attitudes, appreciations, standards of conduct, creative abilities, continuing interests, and insights into natural phenomena that seem desirable if young people are to be equipped to live in a modern culture which is in large measure a product of the sciences.

Life Science in the New General Education

By PAUL B. SEARS*

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THE circumstances which have led the Bureau of Educational Research in Science to give its attention to the problem of science in general education are well known and require no restatement here. Suffice it to say that they emerge from a growing sense of the dislocations within our culture and those between that culture and the rest of nature.

Most of us are aware of ill adjustment within the frame of human culture evident in the relations among men. But to no small extent these evils rest upon an unwise apportionment, ruthless destruction, or sad neglect of the resources of nature—circumstances which are often ignored because of the increasing gulf between the individual and the natural sources of energy and materials.

PROBLEMS OF ENVIRONMENTAL RELATIONSHIP

These are essentially problems of environmental relationship. In technical language, they are ecological. However intricate and specialized the human organism, man is an animal. He can modify many details of his relationship to environment, but he cannot abrogate the laws which govern that relationship. Increasingly these laws must be understood by the individual if he is to participate intelligently in the common task of self-government.

The margin of safety which allows for costly methods of trial and error is rapidly decreasing. Men are pressing closer than ever upon their means of subsistence. For example, at least one third of our topsoil is

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gone, and rural levels of living are lower than they should be. Oil fields are being rapidly drained and a timber famine exists today.

Again, the forces of modern technology multiply the rate at which things can happen. A road gang with shovels working on a ditch of faulty design was less likely to damage the landscape than a modern grader which, in a few days, can completely alter the drainage pattern of an entire creek basin.

Finally, the modern world of men is tighter knit by commerce, transport, and communication of ideas than ever before. Destructive tensions in any one part of this world-wide fabric are immediately felt elsewhere. Persecution of religious or political minorities, monopolistic control of a single raw material, diplomatic insolence, or failure of local military precautions may have prompt and widespread consequences.

Meanwhile the human individual who must make his way under these bewildering conditions is physically and psychically endowed about as he was in Neolithic times. The thing which has changed so vastly is not man himself, but his system of behavior, or his form of culture. Thereby his relations to his fellows and the rest of nature—plants, other animals, and the inanimate—have changed.

This behavior pattern of man has modified the human birth rate, set up new and special strains upon the human body, changed the age groups of society, and altered the environment of man, the animal. It has also, since man is the dominant organism upon earth, profoundly affected most other organisms, even those of the sea. In part this has been by direct action, but to a much greater extent it has been by alteration of the environmental balance upon which native plants and animals have been dependent.

The truth is that the most potent biological force in action upon the earth today is human culture. Yet because the study of that culture is a highly intricate specialty, preoccupied with social pathology or such phases of cultural activity as the mechanics of wealth, this fact has been neglected.

The biologist can no longer dismiss human culture as a purely social phenomenon—a matter for the social scientist. Let him do that and then try to explain the present state of vegetation in the United States, the fate of the bison or the passenger pigeon, the changing human birth

rate, or the increase of nervous disorders and maladjusted personalities.

The social scientists can no longer ignore the biological basis of human behavior or its biological consequences to the human organism and man's environment. As well might the modern physicist choose to ignore mathematics on the one hand and chemistry on the other. The genesis of social behavior is in the neuromuscular history of the growing child. The ends of practical social adjustment are to be sought largely in the capacity of environment, depleted or husbanded, to supply the requirements of man, the organism.

A WORLD OF CHANGE

It follows clearly enough from what has been said that the problem of the developing individual is today far more than the traditional task of adjustment to a fairly static or slowly changing culture whose standards in themselves represented a relative sort of finality. Nor do I consider the problem quite met by saying that we must educate for life in a world of change.

Alexander Pope summed up one possible attitude toward a world that was changing when he said,

> Be not the first by whom the new are try'd,
> Nor yet the last to lay the old aside.

Philip the Second of Spain expressed another attitude by his determination to prevent change at whatever cost in blood and treasure. The gullibles who try to keep up with the Joneses, and the preposterous Joneses themselves who snap up every novelty, casting aside anything familiar, represent a third way of living in a world of change.

Again the modern authoritarian governments, which *must* use all of the resources of new technology to maintain their power, have the difficult problem of encouraging advances in knowledge and practice that will serve their purposes, while checking the course of free inquiry and maintaining a static social pattern. They too have their formula for dealing with the problem of change. There are many ways in which we can educate for life in a world of change.

We cannot prevent change. But neither do we need to lie down and let it roll over us. It is to be hoped that we can, to some extent, guide

and control it in the interest of the common good. To do so we must understand it. And since the cultural process is the agency whereby change is achieved as well as a process in which we all have to participate, I can see little choice but to have the curriculum organized about that process as a deliberate point of focus.

This certainly would justify a different approach to the teaching of science for the nontechnical student. In the case of biology it would even make respectable a consideration of what we have called in a preceding paragraph "the most potent biological force in the world today," namely, the human cultural process.

My own responsibility in connection with the Bureau of Educational Research in Science has involved the preparation of two booklets. One is entitled "The Interrelations of Living Things." It is organized on the basis of generalizations framed with reference to their social significance, as contemplated in Dr. Powers' original plan. The other is called "Human Growth and Development," and draws heavily from a manuscript prepared earlier for the Bureau by Dr. Frank C. Jean. The scope of both booklets may be seen from their tables of contents, here given.

THE INTERRELATIONS OF LIVING THINGS

I. Life and Environment are Inseparable Except for Purpose of Analysis.
II. The Development of Our Knowledge of Environment Has Been Conditioned by Cultural Factors.
III. Human Society Is the Immediate Living Environment of the Individual Human Being, and Is Interwoven with the General Environment. Man, Unlike Other Organisms, Has the Capacity to Understand These Relationships, and Thus the Hope of Controlling Them.
IV. All Living Things Tend to Occur in Communities Which Develop towards a Condition of Equilibrium.
V. The Community Arises Through the Activity of Living Organisms in Relation to Environment. The Role of Any Organism Depends Upon Its Inherited Capacities as These Develop under the Given Conditions.
VI. Life and the Inanimate World Can be Separated Only for Purposes of Analysis. On this Basis the Interdependent Physical Environment is Resolved into Lithosphere (Rock), Hydrosphere (Water), and Atmosphere (Air). Similarly, Life Is Sometimes Grouped into the Biosphere.

VII. Ecology is the Testing and Synthesis of Whatever Can be Known About Life and Environment, in Order to Interpret their Relationship in Scientific Terms.

VIII. The Social Function of Ecology is to Provide a Basis for Shaping the Human Culture Pattern in Relation to Environment.

HUMAN GROWTH AND DEVELOPMENT

I. The Human Being is an Organism which Undergoes More or Less Orderly Change from the Beginning to the End of Life.

II. The Activity of the Human Body Must be in Terms of Its Structural Organization.

III. The Activity of the Human Body is Sustained by Physical and Chemical Changes, Which also Interrelate it with the Environment.

IV. Health is an Important Factor in Maintaining the Efficiency of the Human Body.

V. The Relations of People to Each Other in the Social Process Are Profoundly Influenced by the Limitations and Capacities of the Human Body.

VI. An Understanding of the Scientific Principles of Reproduction, Inheritance, and Variation is Essential to Intelligent Social Adjustment.

Very briefly, indeed, we may sum up the point of view expressed in these two booklets as follows: *All living organisms, including man, live inseparably with their environment, and must maintain a moving balance with it, as the bicycle rider who balances himself on his wheel while moving ahead. This environment consists not only of the inanimate forces and materials but of the behavior patterns of living organisms as well.*

For man the behavior patterns of his own kind are the medium through which he makes his conscious adjustment to the rest of the world. He is shaped by this medium, and it in turn is modified during the whole process of his constantly changing life. As for the human individual himself, he is not only changing as he lives, but he is in some respects unique and so is each of his fellows.

We do not yet know enough about the relative parts played by inheritance and environment. But we can be certain that many of the most important characteristics of people can be culturally modified. Since this is at once the means of adjusting the individual and of shaping the

pattern of which he is part, and likewise a means of human betterment about which we can do something, this shaping of the individual through experience, is by all odds the most serious current business of humanity.

However clearly and completely these principles may be stated, they are mere verbalizing unless taught in the context of the material to which they apply. This material is basically biological, but its implications are not exclusively so. Much could be accomplished by modifying the existing courses in biology, and that should be done.

To my mind, however, the point of view just outlined is of such far-reaching significance that it should be available to every teacher in every discipline. Not only science, but the social sciences, history, and languages can be enriched and made more significant by teachers who are aware of the relationships just discussed.

For that reason the two booklets have been prepared, not as a basis for the introduction of new courses or as syllabi for existing courses in the biological sciences, but for the information of teachers at all levels and in all fields of subject matter. I am not sanguine enough to hope that in their present compact form they will be eagerly read by the majority of teachers. For those whose tastes and preoccupations demand a different approach, other, more popular treatments are available.[1]

METHODS AND OBJECTIVES

In suggesting that teachers make use of a new viewpoint, certain practical questions at once arise. These have to do with methods and objectives. How may present instruction be modified to develop the new viewpoint, assuming that it deserves such emphasis? And what tangible results in the students do we seek?

I see little hope of developing this material convincingly or with enthusiasm except by a curriculum which centers about the actual community in which the school exists. This idea is not novel, in fact it is already in operation in a number of places. Yet it may be questioned whether the teachers generally are aware of the possibilities which it holds for them.

Perhaps the first consideration, applying to instruction in any phase, is

[1]The author's *This Is Our World*. University of Oklahoma Press, Norman, 1937, and *What We Are* (in press).

the fact that it is not something done by the teacher to the student, but an experience in which both participate, as members of a community. No doubt this would be conceded by most teachers without argument as a working principle. In application, however, it is extremely difficult, despite the attention it has had in recent years. Modern schools are attempting a task never before seriously tried—that of general education of the general public. But for that task they are employing a type of organization developed largely as a part of a much older social pattern. Military, feudal, and economic influences appropriate to a very different society from that of the modern world still persist in most schools. The undemocratic character of the average schoolroom has become a byword, but fortunately, a point of departure for new types of teaching practice in which the modern schoolroom becomes a community having some reference to the community at large.

USING THE COMMUNITY

A second point of general importance in this connection is closely related to the first. That is, the importance of using the student's own community as a source of teaching material. One of the most frequent and damaging charges against those who teach in the schools and their students as well is a lack of practical understanding of the realities of everyday life. This is probably not so much because of defect of qualities in the mind of the schoolman as it is because of the traditional pattern which emphasizes attention to words and other symbols while neglecting experience with the things which they represent. Taking biology as a case in point, it is a common experience to find hard-pressed biology teachers struggling through the elaborate symbolic treatment of heredity and evolution, using material from charts and books supplemented by dead-type specimens in alcohol probably shipped in from long distances. Very often neither these teachers nor their students are aware of the wealth of significant material and problems which are lying just outside the classroom door. This illustration could be extended to such varied fields as civics, geography, history, and even the physical sciences.

Perhaps we can best show the possibilities of a new approach by discussing a setup in which it has been possible to make a fresh start. Let us assume that a group of teachers on the secondary or college level have

been assigned the task, not of teaching separate subjects, but of collaborating on the work of acquainting the student with the local community, the larger regional community, and the world community of which he is a part.

In such an undertaking there is not much doubt that the character of the community itself would have an effect upon the choice of emphasis to start with. Children from the professional and mercantile homes in an urban community might be most readily interested in approaching the problem through a discussion of social phenomena. Children from the homes of artisans and mechanics in an industrial area are likely to be more intrigued at the outset by the physical sciences and their application. Farm boys and girls as a rule have a background favorable to interests in the biological sciences. The whole point of these suggestions is that the character of groups and even of individuals is a matter which should be given attention at the outset.

THE WORLD COMMUNITY

In such an ideal system of collaboration the direction of movements should be from the immediate, local, familiar, and tangible to the more general and the more remote. In other words, upon an understanding of the local community should be built a picture of the region of which it is a part. From this region as a source the instruction should proceed until it encompasses the world community. Let us consider, for example, the part played by a teacher trained in history and the social sciences in such a scheme. In many states today there are requirements concerning the teaching of local history. If one examines such instruction he usually finds that it is a chronology of names and dates. It is likely to overemphasize the parts played by individuals more or less accidentally caught in the stream of events. It certainly overemphasizes the part played by artificial political boundaries. It seldom makes clear the relation of such local history to climatic and other geographic factors, to the larger trend of events elsewhere, or to the actual cultural process involved.

In this field alone there is a marvelous chance to break down the rigid divisions, not only between the social sciences and other fields of knowledge, but within the social sciences themselves. At the present

time the student may take a course in the history of his state and remain ignorant of events that have shaped his town or county. He will probably have a course in American history which seems quite detached from what he has learned about his state, and courses in European or world history which again have little to do with either. What student in Iowa, for example, is enabled to see Caesar's bridge across the Rhine, the Roman roads in Britain, the perfection of the mariner's compass, the building of the Erie Canal, and the movement of great railroads across his own state all as parts of one great cultural process?

Something might be said also of the social sciences other than history. These at present face many difficulties. Economics, for example, is sometimes concerned with the conventions of exchange rather than with the environmental realities to which they apply. It lends itself with equal readiness to those who would rigidily maintain and those who would completely replace our present institutions. It can easily become preoccupied with the study of mechanisms rather than relationships and with theories rather than the realities which give rise to them. Sociology is greatly concerned with pathological situations in society, and until recently, has left out of consideration much of significant knowledge which the anthropologist has discovered concerning the nature of normal social relationships and processes. The opportunity exists in these fields to relate them to the local community, the region, and the still larger community of mankind.

Geography is rapidly escaping from its preoccupation with the details of political boundaries and the incidental designations of place. It has led in the development of an understanding of functional regions and cultural processes. It still suffers, however, from outworn conceptions of race difference and from its divorce from history. As much as any other point of view in the curriculum geography needs to be presented not as a separate subject but as a means of illuminating the social and biological sciences.

THE BIOLOGICAL SCIENCES

The biological sciences, naturally, have a great responsibility in a program of the kind which we are discussing. There is, however, at the present time a serious shortage of teachers who could participate in it.

On them will fall responsibility for acquainting the student first of all with the living plants and animals of his region, both native and domesticated, and with the factors in the environment as they relate to the human animal. In learning the living organisms of the area it is less important that the students become acquainted with large numbers of species than that they become familiar with the common kinds and be able to recognize the communities of which they are a part.

Here again constant reference must be made to the fact that the present cannot be understood without a knowledge of the past. The most significant thing today in explaining the pattern of plant and animal communities throughout America is the influence of the white man upon them. Working backward from the present disturbed conditions or ahead from an adequate picture of the original communities, the student should become able to trace the changes wrought by man and the influences which this process in its turn has had upon social developments within his own community.

Such studies afford a natural means of transition from his locality to the region of which it is a part. Suppose he lives in an area originally occupied by oak-hickory forest. Where else is this community found? How far does it extend and in what directions from his own locality? What are the climatic and soil conditions which account for it? What are the biological relations with animals and other organisms which characterize this community? How has it developed? Does it have a counterpart on other continents? What influence has it had upon industrial, commercial, agricultural, and social processes? These are but a few of the many instances in which biology could be made a living part of such an approach as we are trying to describe.

At the present time biological instruction is largely preoccupied with what might be called the formal or symbolic demonstration of the evolutionary theory. It is far more important to understand and emphasize the great framework of relationships and change of which evolution is one expression.

THE PHYSICAL SCIENCES

The physical sciences can be used to great effect as a means for measuring and explaining the complex of local environment which gives the

locality its special characteristics. The physical sciences can also be utilized to advantage in a study of many local industrial activities, such as mining, power distribution, transportation, and chemical industry. These subjects at the present time do make considerable use of their relation to applied science, but not with any reference to the pattern of human activities on the earth.

In addition the physical sciences can be made a valuable agency in emphasizing the continuity of the operation of natural forces over the earth. This is quite as important as an understanding of the variations of physical and chemical conditions from one place to another. The fact that iron will rust and water will freeze on one continent as readily as on another has implications which can be skillfully used in extending the student's interests from his own locality to the larger world community.

It should be emphasized again that the foregoing remarks are not intended as specifications for a complete program but merely as suggestions of what is possible. Also it should be emphasized that any program of this sort must rest upon an organization in which each teacher is thoroughly aware of what the others are about and in which the subject matter divisions are forgotten except insofar as each teacher will use his special knowledge and training to contribute to the desired end.

THE QUESTION OF OBJECTIVES

Frequently the objectives of teaching are stated in very general terms, such as appreciations, skills, sensitivities, and the like. Unless rigorously defined and circumscribed with reference to a particular situation, these are open to the charge of ambiguity. In using such terms, moreover, e.g., changes in concepts—one is likely to run afoul of the rocks of conflicting psychological theory.

When such questions are likely to arise, it may be found most helpful to start by asking, "What sort of changes may I reasonably hope to produce as a result of teaching this material?" or "How may I reasonably expect students to show that they have done this work with me?" Following that, the teacher will be able to describe specific situations to which the students might be expected to respond differently after the

course than before. If he can do this, the task of the evaluator becomes relatively simple, so far as testing the degree to which the teacher achieves his objectives is concerned.

With these very simple considerations in mind, what are some specific situations in which an improved understanding of the interrelations of living things might be expected to show?

1. Verbal knowledge—ability to define such terms as:

living community
succession—in relation to:
  plants,
  animals,
  human culture
equilibrium
food chain
nutrient cycle
culture trait
culture pattern
soil profile
atmospheric factor
biological factors
limiting factor
stimulus and response
life cycle
population growth curve
competition
water cycle
physiographic cycle
succession
climax

Closely involved is the ability to establish logical relationships among such words, recognize contradictions, and make deductions. Clarity and the ability to construct logical verbal statements should accompany an understanding of the verbal equivalence of symbols used.

2. Verbal analysis of concrete situations—ability to:

Name the dominant organisms in a community observed.
Designate the significant communities in the region.
Designate the stages in community development.
Designate the environmental factors operating on human culture in the region.
Designate the steps by which human culture has modified the natural conditions.
Designate the degree of adjustment of culture to—water cycle; soil cycle; climatic factors; etc.

NOTE: In this and the following types of achievement, models of landscapes, etc., are a valuable and legitimate supplement to field work. Maps should be understood as conventionalized models in two dimensions and used as such.

3. Interpretation of symbols in terms of action—ability to:

   Prepare a simple ecological survey map showing community types and locations.
   Find out an instance of: overgrazing wasteful forestry
   roadside erosion good land use
   Find drainage patterns: truncated soil profile normal soil profile
   stream pollution sources
   Make a simple census: plant animal human etc.

4. Action in terms of observed realities:

   Prescribe and design improved land use measures.
   Examine a forest and designate trees for cutting.
   Examine a stream and prescribe measures for improvement.
   Examine and criticize some public project; e.g., highway or park design
   wildlife refuge irrigation or drainage project
   Select membership in organization effective for solving regional problems.
   Advocate legislation in terms of observed conditions.

5. Less tangible but fundamental changes which might be expected.

These can be described only in general, indeed vague terms. They represent the sort of thing which, in practice, we become aware of through continued personal knowledge of people and which are likely to offer obstacles to any impersonal routine testing.

Attitudes: e.g., acceptance of responsibility within the community to secure better adjustment of it to landscape, sewage disposal, forest and soil conservation.

Perspective: e.g., ability to view a local situation as a part of a larger whole, to see events as a part of a trend, etc.

Appreciations: e.g., leisure time, even vocational and economic interests. Consistency of aesthetic attitude with action. Recognition of science as not only a means to practical ends but toward a desirable world view.

Such are some of the possibilities, as I see them, of a new synthesis which can do much to give substance and direction to general education. My only regret is that the need for condensation, here, as in the booklets discussed, may serve to keep some readers at arm's length. Yet I am confident that those teachers whose initiative is essential in any working program will have had the patience and energy to see what is meant.

New Studies in Education

AN ANALYSIS OF THE PROOFS AND SOLUTIONS OF EXERCISES IN PLANE GEOMETRY TESTS*

THE problem of this study was to find the answer to each of four related problems. It undertook (1) to prepare a revised list of geometric theorems based on proposed criteria; (2) to ascertain to what extent the list of theorems of the National Committee on Mathematical Requirements has been adhered to by extramural examinations; (3) to determine the algebraic techniques involved in plane geometry; and (4) to find out to what extent the originals offer an opportunity for methods of analysis and indirect proof.

The following five types of geometry examinations, covering the period 1923-1935, were selected for study, and the solutions of the exercises which they contained were analyzed: Annapolis Entrance Examinations, College Entrance Board Examinations, New York Regents' Examinations, Selected State Examinations, and West Point Entrance Examinations.

A study of the axioms used as basic proofs was taken as indicative of the algebraic techniques involved in the proofs and solutions of the exercises. In addition, special algebraic skills, such as the ability to solve quadratic equations, the ability to factor, and the ability to manipulate radicals were tabulated in order to determine what algebraic abilities are necessary to solve the exercises of this study.

The originals were tested to see if they lent themselves to the analytic and indirect method of proof. As a result, a list of originals whose solution may be illustrative of the analytic method of proof was prepared.

A list of theorems was compiled by tabulating theorems which were common to representative texts.

Five criteria were used to revise the list of theorems recommended by the National Committee on Mathematical Requirements.

FINDINGS

The various facts revealed by the data of this study point to the following significant findings:

The conventional geometric theorems necessary to solve and prove exercises found in present-day examinations have been rated by percentiles as to their utility in proofs and solutions. Only sixteen theorems are required to answer 50 per cent of the reasons used in the geometric proofs.

In the examinations analyzed, 36 per cent of the exercises are applied problems; that is, testing the pupil's ability to apply geometric facts by means of numerical or literal numbers.

The number of originals on these examinations has been decreasing, especially those which have long proofs. The State examinations have resorted to an increased number of questions which are based on one geometric theorem.

* By HALE PICKETT, PH.D. Teachers College, Columbia University, Contributions to Education, No. 747.

Geometric proofs in this study involve the following: theorems, 45 per cent; definitions, 12 per cent; constructions, 8 per cent; postulates, 11 per cent; and axioms, 22 per cent.

The relative frequency of reasons in proofs for various definitions, constructions, postulates, and axioms is established.

The starred and fundamental theorems, as listed in syllabi, not only furnished the originals for these examinations but also served to answer the major portion of the basic reasons in the proofs.

The importance of algebraic abilities is indicated by: (1) the high frequencies of theorems relating to formulas and proportion; (2) the fact that axioms comprised 22 per cent of the basic reasons; and (3) the tabulation of special algebraic abilities.

A major portion of the test items may be solved by the analytic method of proof, but the indirect method of proof is seldom required.

A Persistent List of Theorems has been determined and the list of theorems recommended by the National Committee on Mathematical Requirements has been revised, reducing the eighty-nine individual theorems to fifty-eight, or a 35 per cent reduction.

EDUCATIONAL IMPLICATIONS

The percentile scale of the utility of theorems as basic reasons should be helpful to teachers, general educators, and authors of textbooks and tests. Theorems known to have greater utility should receive greater emphasis. Also, the frequency tables for definitions, constructions, postulates, and axioms should serve as a guide to educators who are interested in teaching geometry.

THE LIBRARY-MUSEUM OF MUSIC AND DANCE*

WHAT are libraries and museums doing about music and dance? What could they do if adequately provided with phonograph records, sound film, acoustical apparatus, and other equipment? What kind of civic center is needed for music and dance materials?

In this study the whole field of education through libraries and museums is reviewed—the astonishing new gadgets, the growing power, and the historic trend of library and museum philosophy. Eighteen aspects of library service and approximately a hundred museum activities are examined to show how libraries and museums are serving young and old. The art museum, the culture history or ethnographic museum, and the museum of science and industry are discussed with reference to their distinctive emphases. Library and museum educational methods are summarized for the general educator as well as for the specialist in music or dance. At each point, however, possible adaptations to the music and dance field are suggested.

As a working hypothesis, it is suggested that a fully equipped modern music center should include the following nine sections or their equivalent: acoustics, instruments, phonograph records, sound film, dance, general or supplementary exhibits (including iconography), library, education and extension, and research. The resulting institution would combine features of a library, a museum, a laboratory, and a theater.

To shape the policy of such a center

*By ARTHUR PRICHARD MOOR, PH.D. Teachers College, Columbia University, Contributions to Education, No. 750.

requires a clear understanding of the varied musical needs of the community and of the resources available. Fifty needs of music and dance which have emerged in the United States during the past fifty years or more are discussed with reference to ways in which the new music center might help to meet them. These problems range from the development of musical literacy for the masses, and the education of listeners, to acoustical research and the training of teachers, writers, professional musicians and dancers.

Following the summary of needs are chapters on library and museum techniques, then a re-examination and expansion of the ninefold proposal for the music museum, in the light of the findings in the surveys.

What can the average community do? The library may expand its service through phonograph records, the museum may exhibit instruments of the modern orchestra with their forebears, and arrange for their practical demonstration. From such beginnings other services may grow. In New York a working agreement has been reached to combine the musical resources of the Metropolitan Museum, the New York Public Library, New York University, and several private collections in a new library-museum of music and dance. Such centers may strengthen the music departments of small libraries and museums. Steps are suggested by which a college music department may also adapt the principles of the new music center, with library and museum facilities, to its needs.

THE PROFESSIONAL EDUCATION OF WOMEN TEACHERS OF PHYSICAL EDUCATION*

UNDERLYING all curricula for the preparation of teachers is the assumption that knowledge of professional subject matter is one factor in teaching success. The purpose of this study was to seek an answer to the question: What are the relationships between knowledge of professional subject matter on the one hand and certain factors possibly related to the acquisition of such knowledge on the other? Staff members and senior women majoring in physical education in forty-six colleges, universities, and teachers colleges participated in the study.

For teachers of physical education professional subject matter consists of knowledge related to the field itself, the basic scientific foundations of the field, and the background of educational philosophy and method. In the present study it is measured by two objective comprehensive tests developed by the author. Form A is a test of professional knowledge in health and physical education; Form B measures achievement in basic science. The tests were administered to women majoring in four-year undergraduate curricula in physical education in the spring of their senior year. Measures of student achievement are derived from the results of the tests.

Other factors studied included the following: age, intelligence test score (Otis Self-Administering Test of Mental Ability), and minor subject of student; years of training and of experience, the range of experience, and the diversity of load of teacher; enrollment, size of faculty and of staff in physical education, number of major students, years of existence of major course, and curricular pattern of the institution. A faculty questionnaire and an institutional data sheet were formulated and

* By HELEN RUTH HAGGERTY, PH.D. Teachers College, Columbia University, Contributions to Education, No. 741.

used to secure information regarding these variables.

In estimating the relation between student achievement and other factors four different procedures were used:

First, where the form of the data permitted, Pearson product-moment coefficients of correlation were computed between student achievement and certain variables.

Second, institutions were ranked according to standing on certain qualities, rankings were combined, and rank-order coefficients were computed between mean combined rank and student achievement.

Third, differences between types of institutions and between institutions belonging to different accrediting agencies were analyzed, using the correlation ratio in the analysis of the variance.

Fourth, the institutions ranking highest and those ranking lowest in student achievement were compared and contrasted.

RESULTS

The following statements summarize the results:

There is a positive relation ($r = +.45$) between student achievement and student intelligence as measured by the Otis Test.

There are positive correlations between student achievement and the following: number of staff members in physical education, years of training and of experience of staff members, years of existence of major course, credit hours in physical education, in basic science, and in total professional education required for graduation. In most cases the values are low, but are indicative of possible relationships.

There is a negative correlation ($r = -.27$) between diversity of load of staff members and student achievement.

The values of the rank-order correlations between student achievement and several combinations of factors lie around .50. A typical combination is the following: number on physical education staff *plus* mean years of training of staff *plus* mean years of experience of staff *plus* mean staff load *plus* mean range of experience of staff.

The variations in student achievement are greater between institutions than within them, between types of institutions than within a given type, between institutions belonging to different accrediting agencies than between those belonging to the same agency. There are equally great differences for the concomitant factors, but they do not parallel exactly the differences for achievement.

There is no overlapping of individual student achievement between the institutions which rank highest and those which rank lowest on the tests of achievement. Parallel divergences for the other variables do not appear.

This investigation affords another illustration of the paradox that variation is a constant characteristic of institutions which prepare teachers. Prospective teachers of physical education secure their preparation in small institutions and in large, in privately-supported and publicly-supported colleges and universities, in institutions avowedly devoted to a diversity of purposes. They pursue curricula differing widely in extent and emphasis, in requirements for graduation and for certification. The qualifications of instructors vary greatly within institutions and even more markedly from one institution to another. The mental ability of the student group is by no means homogeneous. Perhaps it is not to be wondered at that the achievement of the students manifests such great variability. However, in spite of the fact that disparity in student achievement is obvious, to account for it in an adequate manner is an arduous task. The relationships between the results and the correlative variables in learning appear to be exceedingly subtle.

The results of this study are in harmony with those of other investigations which deal with the conditioning factors in learning. There is a positive correlation between achievement and certain associated conditions, although the values of r are

not high. It is probable that, while the value of any single variable may be negligible, the effect of several such together may be quite significant. There are increasing grounds for believing that the results of the educational process are not entirely due to the operation of a few forces in roughly measurable quantities, but that they are the outcome of many interacting elements in the environment of the learner.

In order to arrive at a satisfactory evaluation of the variables which influence learning, the entire situation must be considered as a whole. Even though it is impossible to predict accurately the effect upon achievement of a given variable, it will be valuable to study in a particular department or school of physical education the consequences of increasing or decreasing teacher load, of using teachers with more or less training, of adding more teachers to the staff, of requiring more or fewer credit hours devoted to the major or to basic science, of selecting students on other bases than that of interest alone. Such inquiry should, of course, be carried on in each teacher-preparatory unit, as the administrator and his staff evaluate the worth of various administrative and teaching procedures. The present study may indicate certain aspects which merit further investigation in the case of individual situations.

THE PRONUNCIATION OF VOWEL SOUNDS*

AN EVALUATION OF PRACTICE MATERIAL FOR COLLEGE FRESHMEN

IN AN attempt to measure speech as an improvable function this investigation concentrated on a study of the change in the pronunciation of five English vowel sounds of eighty college freshmen during a controlled experiment conducted at the State Teachers College, Trenton, New Jersey. At the beginning and the end of the experiment two classes of freshmen made an electrical recording of the oral reading of a story and a poem which had been selected because they contained repetitions of the vowel sounds to be rated. The Abbott-Trabue Exercises in Judging Poetry, Form X at the beginning and Form Y at the end, and the Hartley Tests of the Interpretative Reading of Poetry, Form A at the beginning and Form B at the end, were given these same classes. During the interval between the initial and final tests and recordings one class received training with selections from modern poetry, and one class with disconnected sentence drills. Both classes reported their free reading not required for any course. Two other freshman classes received training with practice sentences and poetry selections in counterbalanced order, and then voted as to their preference.

The one hundred sixty recordings were rated independently by four judges who were graduate students in the department of Speech Education at Teachers College, Columbia University. These judges were selected after a period of preliminary tests in judging speech recordings, and then were trained in the rating techniques devised by the investigator. The statistical analysis of the judges' ratings included the technique of matching pairs.

FINDINGS

The following findings are considered significant:

1. The correlation coefficients for the team of four judges indicated the re-

*By Effie Georgine Kuhn, Ph.D. Teachers College, Columbia University, Contributions to Education, No. 757.

liability of the measurment of the speech product. The study, therefore, furnishes a fairly objective method for obtaining speech ratings for experimental purposes, and is an illustration of the successful application of a measuring technique to abilities admitted to be difficult to measure.

2. Sentence practice material and poetry practice material were almost equally effective in bringing about the desired change in vowel pronunciation for the two groups of forty students each and for the twenty-six matched pairs from these classes, although in the latter case the results favor the poetry practice material. The fact that the gains were statistically significant for each group indicates that a speech drill on a specific ability can be incorporated without loss of efficiency in material with interesting content.

3. There were statistically significant gains in the oral reading of prose and poetry for both groups of forty and for the matched pairs. This is objective evidence that drill on one speech factor need not prevent simultaneous improvement in other speech factors if appropriate standards are set up, and that the use of poetry practice material for changing vowel pronunciation does not affect adversely improvement in the oral interpretation of poetry.

4. The poetry practice group improved more than the sentence practice group in judgment of poetry as measured by the Abbott-Trabue Exercises in Judging Poetry. The amount of improvement, however, was not statistically significant.

5. The poetry practice group improved more than the sentence practice group in the ability to understand the meaning of poetry as measured by the Hartley Tests of Interpretative Reading (silent). It is, therefore, reasonable to conclude that attention to a speech technique need not preclude the possibility of gain in the power to interpret meanings in poetry.

6. The majority of one hundred and four students (or 74 per cent) who were given both poetry and sentence practice material in counterbalanced order expressed a preference for poetry drills.

7. The poetry practice group included in their free reading more than three times as much poetry as those in the sentence group. According to the voting on the "appeals" in the poetry practice material used during the experiment, there was an increase in the number of poems appealing and a decrease in the number not appealing. These results lead to the conclusion that the Speech class may rouse and increase interest in poetry by the use of poetry drills.

POETRY PREFERENCES IN THE JUNIOR HIGH SCHOOL*

THE purpose of this investigation was to discover what appeals in poetry are operative with children at the junior high school level. The study was limited to six identifiable appeals, four classifiable as subject matter and two as technique. Each appeal was further divided into *a* and *b* subdivisions to allow for measurement of preference within the appeal. For convenience, the six appeals are called "categories" throughout the study and their subdivisions, "the *a* and *b* subdivisions."

The experimental material consisted of 120 poems assembled into ten units, each unit containing twelve poems, a pair representative of each category. This organization of material was used because it seemed desirable to get choices in each period between categories as well as between pairs.

* By LUCY KANGLEY, Ph.D. Teachers College, Columbia University, Contributions to Education No. 758.

In addition to the poetry study, two subsidiary investigations, a prose study and a pupil interest questionnaire, were undertaken. The prose study consisted of 32 brief stories and essays that paralleled as closely as possible the interest appeals present in the four subject matter categories in poetry. The pupil interest questionnaire contained 32 items that bore upon preferences in moving pictures, stories, and similar related interests. Both the prose study and the questionnaire followed the organization pattern of the poetry study. Their purpose was to discover to what extent preferences for interest appeals in prose and in moving pictures and related amusements of a cultural nature paralleled poetry preferences.

FINDINGS

In all three types of materials used, majority preference was clearly in favor of the simple and obvious. There were marked differences in preferences for the twelve subdivisions in poetry. The three high ranking subdivisions were, in the order named, Obvious Sound Effect, Commonplace Subject Matter, and Obvious Humor. The three low ranking subdivisions were, in the order named, Straight Didactic, Complex Imagery, and Nature without a Center of Interest.

Sex differences in preference influenced choices in poetry, prose, and questionnaire. These differences tended, however, to be in extent rather than in direction. The girls appeared to be more mature in their tastes and more inclined to scatter their choices. They more frequently chose nature poems than did the boys, though such poems were not favorites with either. Their ranking of poems dealing with adventure was fairly high but consistently lower than that of the boys.

Difference in reading ability was significant as a factor in influencing choices, though not so significant as sex. Children of superior ability tended to vary from the group in choices.

Maturation may be a determining factor in influencing choices. Certain similiarities in taste between girls of lower ability and boys of superior ability, as well as other findings, suggest this.

RECOMMENDATIONS

Poetry ordinarily used at the junior high school level is unsuitable, as it is consistently too difficult and too remote from children's spontaneous interests.

Poetry containing such clearly negative factors as introspection, a mood of melancholy, or a didactic tone should be avoided in material selected for children. If, for some reason, such material seems essential, the problems involved in its presentation should be recognized.

Investigation should be made of the specific difficulties involved in the reading of poetry.

Improved techniques need to be developed for the teaching of poetry for appreciation.

Poetry selected for presentation to a group should be of such a nature as to elicit a wide, positive response. Sharp differences in preference suggest that more should be done to develop individual or small-group reading of poetry.

Children's liking for marked rhythm, for sound effects, and for clear descriptive detail should be used as a basis for developing their awareness of the esthetic elements in poetry.

College & Alumni Notes

BOARD OF TRUSTEES OF TEACHERS COLLEGE

At the meeting of the Board of Trustees of Teachers College on Wednesday, November 30, 1938, the following action was taken:

The death of Jane C. Berger, Executive Secretary (retired), on April 27, 1938, was reported.

The following leaves of absence were reported: Academic year, 1938-39, Professor Edwin J. Stringham and Dr. Ella Woodyard. Professor Goodwin Watson's leave, granted for the academic year 1938-39, was changed at his request to the Winter Session of 1938-39 and the Spring Session of 1939-40. Winter Session, 1938-39, Professor Thomas Alexander; Spring Session, 1938-39, Professor Lois Hayden Meek; Winter Session, 1939-40, Professor Edward H. Reisner; Spring Session, 1939-40, Professor William L. Hughes, Professor S. Ralph Powers, Professor R. Bruce Raup, and Professor Maxie N. Woodring.

The following appointments were confirmed: Edwin A. Lee, Ph.D., as Professor of Education, from July 1, 1938; Arthur Lismer, A.R.C.A., as Visiting Professor of Fine Arts, from September 1, 1938; and Earl C. McCracken, Ph.D., as Assistant Professor of Household Administration, from July 1, 1938.

The Trustees acknowledged the gift of $2,000 from Mrs. Winter Mead for the furtherance of the work in Nursing Education and of $5,000 from the Carnegie Corporation, through the American Association for Adult Education, for the proposed study of school buildings and school building plans from the point of view of adult use, under the direction of Professor N. L. Engelhardt.

DIVISION I
FOUNDATIONS OF EDUCATION

Social and Philosophical Foundations

Professor Harold F. Clark attended the meeting of the National Council for the Social Studies held in Pittsburgh, Pa., on November 25 and 26. The 1940 Yearbook of the Council will deal with Economic Education and will be edited by Professor Clark.

On December 28 Professor Clark spoke on "Evidence of the Economic Effects of Education" before the Education Section of the American Association for the Advancement of Science at its meeting in Richmond, Va.

In late October and November Professor Clyde R. Miller spoke to numerous audiences of teachers and citizens on "Propaganda: Dictatorship and Democracy." On various phases of this subject he addressed the Rhode Island Teachers Association at its October meeting in Providence; the Newton, Mass., Community Forum; the assembly of Boston University; zone meetings of the New York State Teachers Association at Watertown and Rochester; the history section of the Wisconsin Teachers Association; the Town Hall Forum in Milwaukee; the Public Forum

of Hammond, Ind.; the National Council of Teachers of English in its annual convention at St. Louis; and journalism teachers of Ohio meeting at Columbus. In addition, Professor Miller has met with alumni in a number of the places where he has lectured.

At the request of Dr. John A. Sexson, president of the American Association of School Administrators, Professor Miller and Professor Lyman Bryson are arranging a meeting on propaganda and intellectual freedom to be held in the Cleveland Public Auditorium on February 26, as the opening main session of the annual meeting of the Association.

Professor Miller discussed implications of propaganda for education in several radio programs during the fall. He spoke as a member of the "People's Platform" over the Columbia network from New York; again over the Columbia network during the convention, Thanksgiving week end, of the National Council of Teachers of English at St. Louis; over the NBC network from the same convention; and again in New York over WEVD, as a member of a symposium dealing with education and radio.

A series of nine articles on propaganda and education by Professor Miller is being published in this year's issues of the *Journal of the New York State Teachers Association.*

Psychological and Biological Foundations

Professor Arthur T. Jersild addressed a meeting of the Elementary School Supervisors of Virginia at Richmond November 22 on child development in relation to the elementary school curriculum.

Professor Jersild is a member of the Committee in charge of the preparation of the Thirty-eighth Yearbook of the National Society for the Study of Education. The title of the Yearbook is "Child Development and the Curriculum."

Professor Jersild and Professor R. L. Thorndike are co-directors of a research project sponsored by the Board of Education, New York City, dealing with an evaluation of the activity program in the New York City elementary schools.

Professor George W. Hartmann spoke on "Chips from a Psychologist's workshop" at the general and special sessions of the Fayette County Teachers Institute which was held in Uniontown, Pa., on November 28.

DIVISION II
ORGANIZATION AND ADMINISTRATION OF EDUCATION

Administration of Teachers Colleges and Normal Schools

Professor E. S. Evenden spent November 28 at a meeting of the Committee on Standards and Surveys of the American Association of Teachers Colleges held at the Hotel Commodore, New York City. Various studies under way in connection with the standards of teachers colleges in the country were discussed at the meeting, and the follow-up study on graduate work in Teachers College was approved for immediate release in order to obtain results before the annual meeting in Cleveland.

Professor W. C. Bagley addressed the mass meeting of the student body of Teachers College called November 22 to protest the Nazi atrocities in Germany. On November 30, at the Dean's dinner to the Trustees of Teachers College, Professor Bagley spoke on "The Present Status of Professional Schools for Teachers"; on December 3 he spoke on "The Curriculum Problem from the Standpoint of an Essentialist" at

a luncheon meeting of the Curriculum Club; and on December 8, on "The Significance of the Essentialist Movement in Educational Theory" at a breakfast meeting of the Elementary Education Club.

Administration of Public School Systems

Professor N. L. Engelhardt gave an address before one of the conferences held by the Bureau of Personnel Administration at the Engineering Societies Building in New York City on December 8. His subject was "The Responsibilities of American Education—To the Individual, to Industry, and to Society."

The Administration Club held its annual Christmas party for children on December 19 in the Grace Dodge Room. A large number of faculty members, graduate students, and children were present. Santa Claus appeared and presented a gift to each child, and a puppet show provided entertainment for both children and adults.

Professors George D. Strayer, John K. Norton, and Willard S. Elsbree, spent the first two weeks of December in St. Louis, in connection with the survey of the public schools being conducted in that city. They were accompanied and assisted by a group of ten graduate students who are majoring in Educational Administration.

Administration of Secondary Schools

Professor Thomas H. Briggs has prepared the article on high schools for the *Dictionary of American History*, which is being written under the editorship of James Truslow Adams.

Professor Herbert J. Arnold of the department of Natural Sciences was the guest speaker at the December 1 meeting of the Secondary Education Club. "A Trip to Iceland" was the subject of his illustrated lecture.

On December 6 and 8 Professor Will French spoke to the northern and southern divisions of the New Jersey Secondary School Principals Association at Springfield and Glassboro, respectively. He discussed the curriculum proposals contained in the Orientation Committee's reports.

The annual winter luncheon of the Secondary Education Club was served in the Grace Dodge Room on December 10. Professor I. L. Kandel presented a discussion on the question "Teachers' Rights or Teachers' Obligations?"

Professor and Mrs. Briggs entertained the Secondary Education Club in their home on December 15. A very entertaining feature of the evening was Professor Briggs's reading of Roark Bradford's charming story, "How Come Christmas?"

Administration of Rural Education

Professors Edmund deS. Brunner and Frank W. Cyr attended a conference on Advanced Professional Training for Agricultural Extension Workers, which was called by Teachers College and presided over by Dean William F. Russell during the meetings of the American Association of Land Grant Colleges on November 13. At this conference the problems of advanced professional training for Extension workers were discussed with a group of state and national leaders in that field from the standpoint of the part which Teachers College can play in providing such training.

Professor Cyr spent November 15 and 16 in Portales, N. M., advising the faculty of Eastern New Mexico Junior College there. This college is doing outstanding work in utilizing community re-

sources to meet the needs of its students living in the Great Plains region.

The committee of the Department of Rural Elucation of the National Education Association on a Policy for Rural Education in the United States is now preparing a final draft of its report. Professor Cyr, chairman of the committee, spent December 2 in Washington, D. C., working on this report.

On December 3 and 4 Professor Cyr met with the Committee on the Economic Status of the Rural Teacher, which has completed its survey and is writing its final report to be published in February.

Dr. M. C. S. Noble, Jr., returned December 12 from an eight-week field trip to rural schools, state education departments, and school bus manufacturers, in connection with a national study of Pupil Transportation. He visited fourteen states in a trip which took him as far west as California, studying the types of problems which arise in the varying conditions found in the Prairie states and in the Great Plains and mountain areas, and the effect of a varying amount of state support and control upon the general program of transportation.

On December 5 to 7 Dr. Noble attended a conference in Des Moines, Iowa, called by the United States Office of Education and held under the direction of Dr. H. A. Alves, to develop a uniform system of accounts and records for the public schools, particularly in the field of Pupil Transportation.

Contributions of Teachers College alumni to the 1939 Yearbook of the Department of Rural Education of the National Education Association will represent many rural regions and rural activities. The editor of the Yearbook, which is entitled "Discovering, Developing, and Using Community Resources in the Rural School," is Dr. Kate V. Wofford, of the State Teachers College, Buffalo, N. Y. Miss Lois Clark, who has recently become a member of the State Department of Education in Pennsylvania, presents techniques of discovering community resources, and among those who have discussed the development and use of resources are Dr. Ruth Henderson of the Virginia State Department of Education; Miss Annie M. Cherry, director of the Spring Hope Educational Experiment in North Carolina; Miss Orpha R. McPherson, of the Indian Service, located in Arizona; and Mrs. Helen A. Whiting, State Supervisor of Negro Elementary Schools in Georgia. Professor Fannie W. Dunn concludes the Yearbook with an evaluation of the educational movement to integrate the school and the community.

Professor Mabel Carney represented rural interests of Teachers College at the twenty-first annual session of the American Country Life Association at the University of Kentucky, Lexington, early in November. The general theme of this conference, "Disadvantaged People in Rural Life," was interpreted to include rural population on poor land, farm laborers, and tenants and sharecroppers. Particularly noteworthy were the sessions of the Rural Youth Section, which enrolled more than three hundred delegates from teachers colleges and agricultural institutions of the Middle West and adjoining states. Important addresses and committee reports of this meeting appear in the December issue of *Rural America*, official publication of the Association. This magazine may be obtained at 297 Fourth Avenue, New York, for twenty cents a copy.

A new departure of the Rural Club this year necessitated by the increasing number of evening classes has been daytime meetings held on Monday afternoons from three to four-thirty. Officers of the club for the Winter Session are as follows: President, Raymond Patterson, Morrowville, Kan.; vice-president, William H. MacKenzie, Moncton, New Brunswick;

secretary, Anne S. Hoppock, Belvidere, N. J.; treasurer, Katie L. Downs, Carrollton, Ga.; and executive committee members, Hilda M. McCoy, Holly Springs, Miss., and Grace D. Cunningham, Salem, Ark.

The Negro Education Club, which has been meeting monthly, has the following officers for the Winter Session: President, J. B. MacRae, Fayetteville, N. C.; vice-president, Oscar J. Chapman, Pine Bluff, Ark.; secretary, Evelyn F. Gair, Baton Rouge, La.; treasurer, Mrs. Anne C. Preston, Prairie View, Tex.; and executive committee members, George N. Redd, Tyler, Tex., and Lucille E. Young, Charleston, S. C.

Miss Josephine Murray, director of music, Santa Barbara, Calif., and Dr. Effie G. Bathurst, of the United States Office of Education, Washington, D. C., both alumni of Teachers College, are the authors of *Creative Ways for Children's Programs*, a book on school entertainments published recently by Silver, Burdett and Company. The foreword was written by Professor Dunn.

Administration of Adult Education

On November 3 Professor Lyman Bryson spoke at the luncheon in honor of Dr. Edward S. Burdell on the occasion of his induction as director of Cooper Union. The subject of his address was "Cooper Union and Social Philosophy." On November 12 Professor Bryson addressed a meeting of the New Jersey State Teachers College Association at Atlantic City on "Making Minds for This World."

Professor Bryson was chairman of the Annual Demonstration Debate broadcast over the National Broadcasting Company network on November 18 under the auspices of the National University Extension Association.

DIVISION III
GUIDANCE

Student Personnel Administration

On December 7 Professor Sarah M. Sturtevant took part in a panel discussion held at the Town Hall Club, New York City, on the topic "Altering Concepts in Guidance and Training." The discussion was led by Dr. Ira S. Wile and sponsored by The Association for Personality Training. On December 12 Professor Sturtevant spoke at a luncheon meeting of the Bellevue Occupational Therapy Committee on "Modern Trends in Education."

Professor Harriet Hayes has recently been elected to the Board of Trustees of the Finch Junior College, New York City.

On December 5 Professor Ruth Strang spoke to the Council of Group Work Agencies meeting with representatives of the Board of Education of Hartford, Conn., on the subject "Interrelationships between the Guidance Programs of the Public Schools and the Services Offered by Group Work Agencies."

Professor Esther Lloyd-Jones attended a meeting of the Committee on Student Personnel Work of the American Council on Education held December 16 and 17 at the Hotel Roosevelt, New York City.

Guidance and Personnel

At its second meeting of the fall semester, on December 1, the Teachers College Branch of the National Vocational Guidance Association had the pleasure of hearing Dr. Wesley Pierce, psychologist on the staff of the National Institute of Industrial Psychology in England, discuss "Viewpoints in Vocational Psychology." Dr. Pierce compared his concepts of the field of vocational psychology in England with the fields of industrial psychology and

vocational guidance in the United States. He described the current research project of the National Institute of Industrial Psychology on occupational selection and guidance in one industrial area of Scotland, and read excerpts from the forthcoming publication of this project.

On December 1 Professor Harry D. Kitson addressed the St. Louis, Mo., Women's Chamber of Commerce on the general subject of vocational guidance. He also addressed a committee representing various civic interests of the city of St. Louis on "The Schools of St. Louis."

Mrs. Margaret Griffith has a part-time position as vocational counselor for industrial and clerical workers in the Junior Division of the International Institute of the Y.W.C.A.

Mr. Telford Blough (A.M. 1932) has been appointed vice-principal of Conemaugh Township High School, Davidsville, Pa.

Miss Janet Ewing (A.M. 1938) is director of the Volunteer Placement Bureau, Greater New York Federation of Churches.

On December 10 a Conference on Guidance for superintendents and supervising principals in the metropolitan area of New York was held at Teachers College under the chairmanship of Professor Clarence Linton. Fifty-nine persons attended the conference. Papers by members of the Teachers College faculty and statements describing the organization of guidance in suburban school systems were presented as follows:

"Some Mental Hygiene Problems Which Demand Attention in Education Today," Mr. Douglas Spencer; "Report of the Committee on Psychological Service to Schools and Communities Prepared by a Committee of the American Association for Applied Psychology," Professor Percival M. Symonds; "The Guidance Laboratory of Teachers College and the Services Which It Renders," Professor Esther Lloyd-Jones; "The Need for Vocational Guidance and Its Organization in Schools," Professor Harry D. Kitson; "The Organization of Guidance in the Schools of Elizabeth, N. J.," Mr. Ira T. Chapman, superintendent of schools, Elizabeth, N. J.; "The Organization of Guidance in the Rye High School," Mr. Harold E. Hollister, dean of boys, High School, Rye, N. Y.; "The Organization of Guidance in the Schools of Scarsdale, N. Y., Mr. Vernon G. Smith, superintendent of schools, Scarsdale, N. Y.

The conference adjourned for luncheon at the Men's Faculty Club, after which the discussion of the papers presented in the morning was continued.

DIVISION IV
INSTRUCTION

Curriculum and Teaching

At a meeting of the Essex County Teachers Association, held in Boston on November 4, Professor L. Thomas Hopkins spoke on "Integration—Its Meaning and Application."

Professor Hopkins was one of the principal speakers at the meeting of the Southwestern District of the Montana State Teachers Association, held at Bozeman November 27 to 29. The subjects of his talks were "The Integrating Personality," "The Growth Needs of Children," "Emerging Conceptions of Learning," "How to Develop an Experience Unit," and "Desirable Curriculum and Teaching Practices."

Early in November Professor Hopkins made his semiannual visit to Pasadena, Calif., where he is acting as curriculum consultant in the reshaping of the secondary school program from the seventh grade through the junior college. While in

California Professor Hopkins addressed a group of Los Angeles County secondary school teachers who also are interested in the problem of revision of the secondary school curriculum.

On November 25, Professor W. B. Featherstone spoke to the high school section of the National Council for the Social Studies meeting in Pittsburgh, Pa. The subject of the discussion was "The Social Education of the Non-Academic."

Social Science

Professors Merle Curti, Arthur E. Bestor, Jr., and Erling M. Hunt attended the meeting of the Middle States Association of History and Social Science Teachers held at Atlantic City on October 28 and 29. Professor Curti spoke on "Needed: a History of American Patriotism." Professor Bestor will edit the 1938 volume of *Proceedings* of the Association.

Professor Hunt assisted in the survey of St. Louis public schools which is being conducted by the Division of Field Studies of Teachers College.

Professor Henry Johnson is now teaching in the evening session of Hunter College, New York City, but will return to the University of Minnesota for the 1939 summer session. Professor Johnson is at work on the revision of *The Teaching of History in Elementary and Secondary Schools*, which is published by The Macmillan Company.

Professor Harold F. Clark and Professor Hunt attended the meetings of the National Council for the Social Studies held in Pittsburgh, Pa., on November 25 and 26. Professor Clark will edit the 1940 Yearbook of the Council, which will deal with economic education; Professor Hunt will continue to edit *Social Education*, the journal of the Council.

Natural Sciences

Professor S. R. Powers attended the Thirteenth Conference on the Education of Teachers in Science, held at Rhode Island College of Education, Providence, November 4 and 5. The general topic of the Conference was "Redirection of Teacher Education in the Content Areas." Professor Powers spoke on "Science Teaching for General Education."

Professor Powers participated in the survey of the St. Louis schools conducted by the Division of Field Studies, working particularly with problems of science teaching.

On November 17 Professor G. S. Craig addressed the Teachers Club of the Northwest Supervisory District of Falls Village, Conn., on "The Part That Science Plays in a Program of Education in Child Development." Professor Craig was discussion leader at the New Jersey Regional Conference of the Progressive Education Association held at the State Teachers College, Montclair, N. J., on December 3.

Professor F. L. Fitzpatrick spoke on "Problems of Biology Teaching" before the Association of Science Teachers of the Middle States at Atlantic City, N. J., on November 26.

Speech

Professor Magdalene Kramer addressed the members of the Speech Society of Hunter College, New York City, on November 29. Her subject was "Speech Curriculum."

Fine and Industrial Arts

Professor Arthur R. Young lectured at Wilmington, Del., on October 25 and November 21, on "The Modern Forms in Art," and "New Developments in Paint-

ing." On December 4 he spoke before the Graduate Club of Teachers College on "Cultural Resources of New York City," and on December 5 he lectured to the Camera Club on "Composition."

Professor Fred Strickler met with the industrial arts teachers of Bergen County, N. J., in their regular fall meeting at Hackensack on November 28. He discussed "Curriculum Proposals in Industrial Arts That Can Never Be Realized."

Household Arts and Science

Professor Benjamin R. Andrews spoke before the annual conference of the Society for the Advancement of Management, held at the Hotel New Yorker December 8, on "Maintaining a Balance between Technical Development and Human Relations in the Field of Home Management."

Professor Andrews contributed an article to the February issue of *The Journal of Home Economics* on the establishment of *The Journal* in 1909. Professor Andrews was the first editor of this magazine, and secretary-treasurer of the American Home Economics Association at the time of its inauguration.

Professors Anna M. Cooley, Helen Judy-Bond, and Cora M. Winchell attended a dinner at the Hotel Commodore, at which the report on Education in American Life was presented. This report summarizes three years of inquiry into the status of education in New York State and makes recommendations for changes. President Nicholas Murray Butler, Mr. Owen D. Young, and Dr. Luther Gulick were speakers. The meeting was held under the auspices of the Public Education Association of New York City.

Professor Judy-Bond attended the meeting of the Association of Land Grant Colleges and Universities held in Chicago November 12 to 16. While in Chicago, she gave a talk to the students and faculty in the department of home economics of Mundelein College.

At the Conference of Food Service Directors which was held in Rochester, N. Y., on November 5 and 6, Professor Judy-Bond represented the American Home Economics Association and was one of the guest speakers at the banquet.

Vocational Education

On November 11 Professor Edwin A. Lee addressed the General Session and the Secondary Education section of the Eighty-fourth Annual Convention of the New Jersey State Teachers Association at Atlantic City. On November 18 he was the visiting speaker at the Second Annual Autumn Conference on The Improvement of Teaching, held at the University of Denver. The general topic of the conference was "How to Utilize the Resources of the Community in the School."

Professor Lee delivered the following addresses before the Texas State Teachers Association at Dallas on November 25 and 26: "Vocational Education and Successful Living" (General Session); "Craftsmanship" (Industrial Education Section); "Occupational Implications in Educational Guidance" (Vocational Guidance Section); "Crops or Weeds" (Vocational Education in Agriculture Section); "A Layman's Point of View" (English Section); "Food for Thought" (Vocational Education breakfast).

On November 30 Professor Lee spoke at the opening session of the American Vocational Association in St. Louis. His topic was "An Overview of Occupational Adjustment." He was chairman of a panel discussion on "Youth's Frontier" at the annual convention of State Directors of

Vocational Education, and also spoke on "Occupational Adjustment for Youth" on November 30 over a coast-to-coast network.

Professor Lee attended the Cleveland Conference in Chicago on December 2 and 3.

Commercial Education

Professor Hamden L. Forkner attended the meeting of the National Commercial Teachers Federation, which was held in Chicago December 27 to 30.

Physical Education

Professor W. L. Hughes served as a member of the discussion panel following a demonstration lesson on health teaching given at the meeting of the New York City Health Education Teachers Association on December 14. He also served on the panel of the Teacher Education Section at the New York State Physical Education meetings at Syracuse on December 26.

Professor Hughes addressed the National Convention of the College Physical Education Association in Chicago December 28 on "Basic Principles Underlying the Organization of the Required Program." On December 30 he led a panel discussion following reports on "How We Do It" at a joint meeting of the College Physical Education Association and the National Collegiate Athletic Association.

EDUCATIONAL DEMONSTRATION AND PUBLIC SERVICE

Horace Mann School

Five students of the sophomore class at Horace Mann School, accompanied by their social studies teacher, Miss Irene Lemon, spent the week end of December 2 in Boston visiting points of historical and literary interest. The trip, proposed and planned by the students, grew out of the interest aroused by a recent unit in Colonial history.

Miss Mary Harden spoke before the Parent-Teacher group of the Woodhull Day School, Hollis, L. I., on "Utilizing Community Resources in the Education of Children."

Miss Marion Flagg spoke on "Tonal Learning" at a meeting of the Music Teachers National Association held in Washington, D. C., December 28 to 30.

Miss Katherine Hill addressed the Kindergarten-Primary Association of Staten Island November 17 on the topic "Science Experiences for Five to Eight-Year-Olds."

New College for the Education of Teachers

Dean William F. Russell has appointed the following committee to consider the problem of the amalgamation of the New College program with the regular program of Teachers College: Professor Hollis L. Caswell, chairman, Professor E. S. Evenden, Professor Erling M. Hunt, Professor S. Ralph Powers, Professor Florence B. Stratemeyer, and Professor Donald G. Tewksbury. The committee has been asked to recommend the best way to care for the interests of the present students of New College who wish to continue their work in Teachers College.

In a statement to the *New York Times* Dean Russell commented as follows on the discontinuance of New College:

"New College was established by Teachers College in 1931 as an experiment. It was to demonstrate a new and better form of education for beginning teachers. Teachers College was prepared to supply quarters, maintenance, and overhead ex-

pense. It was hoped that the annual deficit would not exceed $10,000 a year. It was understood that an undergraduate college would be at a severe disadvantage housed in the midst of a postgraduate institution; and it was hoped that funds might be secured for a permanent endowment and satisfactory quarters.

"At the close of the fifth year it was found that the annual deficit was beginning to mount. At the beginning of last year it was seen that New College faced a serious financial problem. At that time a committee under the chairmanship of Dr. Jesse Newlon made a thorough study of New College and reported that the enterprise could not maintain its leadership without substantial additional financial subsidies from Teachers College or from gifts. The committee doubted the wisdom of continuing New College without a substantial endowment.

"New College was continued for this year with a restricted program and greatly diminished budget in the hope that it might make an appeal for substantial aid from outside sources. As soon as this hope failed us, the Administration and Trustees came to the reluctant conclusion that we could not support New College as a separate enterprise after June 30, 1939.

"It is not the intention of Teachers College to abandon experimentation in the field of the education of beginning teachers. We have many graduates of liberal arts colleges who come to us for a year who have had no teaching experience. If the Junior College idea should spread in the East, there may be juniors who would wish to follow a three-year course leading to a Master's degree. We have now made such an arrangement with Barnard and Columbia Colleges.

"The abandonment of an experimental project at the height of its influence is an established policy of Teachers College. The Speyer School, which led the way to modern elementary education, was closed but its ideas were adopted everywhere. The old School of Practical Arts was the pioneer of a new form of undergraduate college education for women. It was abandoned, but the idea was incorporated in every Land Grant College in the United States. The Bureau of Curriculum Research was continued only for a few years. Today similar bureaus are attached to most of the school systems of the United States. The New College idea will not die. It is influencing teacher education not only in the United States but in many other countries of the world; and it is our intention to study the results of this experiment from every angle, publish our conclusions, and incorporate in our other educational programs as much of the New College idea as we find successful and within our means."

THE LIBRARY

Professor Eleanor M. Witmer attended the Midwinter meeting of the American Library Association, which was held in Chicago December 27 to 31. Professor Witmer is a member of the Council of the Association.

Miss Helen Lawrence Scanlon, supervisor of the School Library Laboratory, spoke on "American Colleges in the Near East," and showed color films of these schools to the School Librarians Section of the New Jersey State Teachers Association at Atlantic City on November 12.

The December issue of *Classroom Literature*, the monthly publication of the School Library Laboratory, is entitled "Religious Books for Children." It mentions the outstanding books in this field, both old and new, and describes each briefly.

The November issue of *The Library Consultant Book List*, entitled "Improvement of Study Habits," has been prepared in answer to requests from students for material which would suggest economical

methods of study. The December issue, "The Teacher Looks at the Library," lists some of the recent books on education which discuss the school library from the viewpoint of the schoolman and indicate its place in the directed study movement of the school. Single issues of this publication are available at five cents; the subscription price is fifty cents for ten issues.

Professor Carter Alexander spent November 14 and 15 in Greenbelt, Md., studying the high school problems connected with the Federal model village project.

During the first week in December Professor Alexander attended an educational conference in Chicago and spent a day at Lansing studying the Michigan state curriculum project directed by Mr. J. C. Parker.

OFFICE OF PLACEMENT SERVICE*

The following list continues the appointments reported by the Office of Placement Service in the December RECORD:

Stuntzner, Myrtle A. (A.M. 1931), nursery school teacher, Smith College, Northampton, Mass.

Super, Donald E., assistant professor of educational psychology, Clark University, Worcester, Mass.

Swanson, Herbert G., teacher of Latin, track, and intramural activities, High School, Millburn, N. J.

Sykes, Clara F. (A.M. 1936), superintendent, Browning School, Camden, S. C.

Sykes, Earl F. (Ed.D. 1937), associate professor of education, State Teachers College, West Chester, Pa.

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Taylor, Rachel W. (A.M. 1928), teacher of art, State Normal School, Oneonta, N. Y.

Tennyson, Harry L. (A.M. 1933), supervising principal, Burgettstown-Smith Township Schools, Burgettstown, Washington County, Pa.

Thomas, Portia H. (A.M. 1938), instructor in public school music, Talladega College, Talladega, Ala.

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Thompson, Ralph E. (A.M. 1938), teacher of science and English, Junior High School, Huntington, L. I.

Thompson, Will S., instructor in chemistry, Adelphi College, Garden City, L. I.

Thomson, Mary Irene (A.M. 1938), teacher of physical education and hygiene, Ferry Hall, Lake Forest, Ill.

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Tramer, Helen S., teacher of homemaking, Lexington School for the Deaf, New York City.

Troeger, Elsie M. (A.M. 1933), director of food service, Y.W.C.A., New Haven, Conn.

Tulloss, Hazel K., teacher of English, Junior High School, Westwood, N. J.

Turnbull, Isobel M., teacher of four- and five-year-olds, Day School, Erie, Pa.

Umfleet, Kenneth R., professor of piano and music education, Knox College, Galesburg, Ill.

Van Avery, Dwight (A.M. 1931), teacher of English, High School, Auburn, N. Y.

Van Campen, Marion (A.M. 1935), associate professor of education, Kent State University, Kent, Ohio.

Vander Werf, Lester (A.M. 1938), head

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of English department, High School, Cobleskill, N. Y.

Van Dusen, Ruth (A.M. 1937), commercial teacher, High School, Goshen, N. Y.

Vickery, Gavena C. (A.M. 1938), kindergarten teacher, Public Schools, Green Bay, Wis.

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Vogel, Alice W. (B.S. 1937), teacher of kindergarten, Davison Avenue School, Malverne, L. I.

Vogel, Virginia B., second grade teacher, Lindner Place School, Malverne, L. I.

Wagner, Jean (A.M. 1933), teacher of English, Junior High School, Hackensack, N. J.

Walke, Nelson S.(Ph.D. 1937), head of physical education department, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

Wallace, Helen K., adviser to women and teacher of art, Hofstra College, New York University, Hempstead, L. I.

Waller, Helen Denham (A.M. 1935), director of books course, Pratt Institute School of Library Science, Brooklyn, N. Y.

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Weeks, Louise B. (B.S. 1920), dietitian, Riverdale Country School for Girls, Riverdale-on-Hudson, N. Y.

Weigel, Alice (A.M. 1938), instructor in home economics, Junior High School, Elizabeth, N. J.

Weir, Clara B. (A.M. 1933), instructor in speech and dramatics, Limestone College, Gaffney, S. C.

Welles, Henry H., headmaster, New Canaan Country School, New Canaan, Conn.

Welo, Edna M., manager of high school cafeteria, High School, Tottenville, N. Y.

Welsh, Marie S. (B.S. 1927), manager of hospitality shop, United Hospital, Port Chester, N. Y.

Westbrook, Elizabeth, teacher of French and Latin, Junior High School, South Orange, N. J.

Wharton, Kathryn L. (A.M. 1938), teacher of geography, Junior High School, Needham, Mass.

Wheat, Leonard B. (Ph.D. 1931), assistant dean, arts and science, and head of education department, Central Y.M.C.A. College, Chicago, Ill.

Whitacre, Elizabeth S. (B.S. 1938), second grade teacher, Seaman Avenue School, Freeport, L. I.

Wienier, Leonard P., instructor in biology and general science, Western State Teachers College, Kalamazoo, Mich.

Wietz, Roy J., assistant football coach and instructor in physical education, University of Vermont, Burlington, Vt.

Wiley, Nettie L. (A.M. 1937), kindergarten teacher, Stevens Hoboken Academy, Hoboken, N. J.

Wilkinson, Natalie (A.M. 1935), supervisor of art, New Haven State Teachers College, New Haven, Conn.

Willey, Emily B. (A.M. 1938), instructor in household arts, State Normal School, Plattsburg, N. Y.

Wilson, Emily P. (A.M. 1938), field secretary, Girls' Friendly Society, New York City.

Wishard, Margaret, school nurse-teacher, Public Schools, Cranford, N. J.

Witcomb, J. Hazel Mrs. (A.M. 1937), teacher of history, The Ogontz School, Rydal, Pa.

Wolfe, Geneva (A.M. 1937), home demonstration agent, New Jersey State College of Agriculture, Flemington, N. J.

Wolff, Charlotte G., teacher of home economics, Public Schools, East Orange, N. J.

Wood, Hugh B. (Ed. D. 1937), associate professor of education, Alabama Polytechnic Institute, Auburn, Ala.

Yarbrough, R. Clyde (A.M. 1938), instructor in speech, Episcopal Theological School, Cambridge, Mass.

Zeisel, Frances, instructor in algebra, Jonathan Dayton Regional High School, Springfield, N. J.

Zimmerman, Elaine V., teacher of music and English, Public Schools, Elizabethville, Pa.

Zischkau, Dorothy L., kindergarten teacher, Day Nursery, Plainfield, N. J.

Zwolanek, Helen K. (A.M. 1938), teacher of clothing, St. Joseph College, West Hartford, Conn.

The following recent appointments of Teachers College Alumni are reported by the Office of Placement Service:

Abercrombie, Margaret, teacher of home economics, Peabody School, Georgia State College for Women, Milledgeville, Ga.

Allison, John R. (A.M. 1928), head of mathematics department, The Bolles School, Jacksonville, Fla.

Amerson, Vera M. (A.M. 1928), instructor in commercial education, Muskingum College, New Concord, Ohio.

Anderson, John P. (A.M. 1932), instructor in educational psychology, Hendrix College, Conway, Ark.

Bailey, Marian King, director of social arts, Long Beach Junior College, Long Beach, Calif.

Ballhaussen, Louise E., teacher of mathematics, Oak Grove School, Vassalboro, Me.

Barnes, Gertrude A., music supervisor, Menaul School, Albuquerque, N. M.

Barthold, Homer M., music supervisor, Public Schools, Atlantic Highlands, N. J.

Bawden, Herrick Talbot (A.M. 1926), director of student teaching, Ohio Wesleyan University, Delaware, Ohio.

Beach, Fred F. (Ph.D. 1933), administrator of adult education, Board of Education and W.P.A. Program, New York City.

Beamer, Mary Ethel (A.M. 1938), teacher of commercial education, High School, Glens Falls, N. Y.

Bedrossian, Nuvart, teacher of functional art, Asheville Normal and Teachers College, Asheville, N. C.

Beery, Viola M. (M.S. 1930), director of Commons and assistant professor of institution economics, University of Wyoming, Laramie, Wyo.

Benton, Athlein (A.M. 1933), head of department of commercial education, High School, Chapel Hill, N. C.

Betts, Olive, instructor in interior decoration, University of Texas, Austin, Tex.

Biddle, Mark, instructor in music education, Winthrop College, Rock Hill, S. C.

Bier, Margaret A., librarian, School of Practice, State Normal School, New Paltz, N. Y.

Bigelow, Eleanor M. (M.S. 1927), nutrition supervisor, Visiting Nurse Society, Philadelphia, Pa.

Bishop, Myra Leslie (A.M. 1937), assistant professor of foods and cookery, University of Tennessee, Knoxville, Tenn.

Blackburn, Adaline (B.S. 1938), second grade teacher, Public School, Chappaqua, N. Y.

Bordelon, Pearl (A.M. 1938), director of health and physical education, Bolton High School, Alexandria, La.

Bowhay, George, cadet teacher of mathematics, Gould Academy, Bethel, Me.

Bridenbaugh, E. Paul (A.M. 1930), teacher of mathematics, High School, Point Pleasant Beach, N. J.

Brodbeck, Mary E., teacher of speech correction, Harewood, The Woods School, Langhorne, Pa.

Brome, Robert I., teacher of English, Central High School, Waterville, N. Y.

Brooks, Virginia B., second grade teacher, Public Schools, Tenafly, N. J.

Brown, Ernest S. (A.M. 1935), principal, Robert E. Fitch High School, Poquonnock Bridge, Conn.

Bull, Dorothy A. (A.M. 1932), general secretary, Y.W.C.A., Danville, Va.

Butler, Vera M. (B.S. 1923), associate professor of education, Connecticut College for Women, New London, Conn.

Cain, Ruth E. (A.M. 1931), director of

nursery school, Greenwich House, New York City.

Cannon, Deborah (A.M. 1938), supervisor and principal of Rural Laboratory School, Tuskegee Institute, Tuskegee, Ala.

Champlin, George R. (A.M. 1936), principal, Henry Barnard School, New Rochelle, N. Y.

Cheyette, Irving (Ed.D. 1936), director of music department, State Teachers College, Indiana, Pa.

Close, Emelyn H. (A.M. 1936), music teacher, Public Schools, Louisville, Ohio.

Clark, Hazel Ruth (A.M. 1935), student personnel officer, Woman's College of University of North Carolina, Greensboro.

Clark, Helen T. (A.M. 1936), instructor in foods and home management, Kansas State Teachers College, Emporia, Kan.

Clark, Katharine I. (B.S. 1937), principal and teacher, Community School, Istanbul, Turkey.

Common, June M. (A.M. 1937), teacher of science, Buena Vista School, Colorado Springs, Colo.

Corliss, Amy L. (B.S. 1927), teacher of foods and cafeteria manager, High School, Hastings-on-Hudson, N. Y.

Cox, Luther B. (A.M. 1938), instructor in English, Oklahoma Baptist University, Shawnee, Okla.

Cranmore, Marion, second grade teacher, Fred E. Maples School, Dearborn, Mich.

Cudlip, Catherine Anne (A.M. 1938), student personnel officer, Stephens College, Columbia, Mo.

Cutler, Mabelle G. (A.M. 1935), mental examiner and psychologist, Wayne County Training School, Northville, Mich.

Darnell, Virginia (B.S. 1938), teacher of instrumental music, Caddo Parish Elementary Schools, Shreveport, La.

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De Lano, Elizabeth S., counselor and teacher of English, Central Junior High School, Benton Harbor, Mich.

Dent, Diana Savage (A.M. 1932), director of home economics, North Carolina College, Durham, N. C.

Dering, Frances T. (A.M. 1938), kindergarten and first grade teacher, Belmont Boulevard School, Elmont, L. I.

Dixson, Mary L., teacher of science, Junior High School, Benton Harbor, Mich.

Dominge, Grace F. (A.M. 1934), teacher of fine arts, High School, Manhasset, L. I.

Dunn, Gordon, assistant professor of art education, Louisiana Polytechnic Institute, Ruston, La.

Ellsworth, Lola, instructor in home economics, Gila Junior College, Thatcher, Ariz.

Everest, Allan S. (A.M. 1937), instructor in economics and government, Green Mountain Junior College, Poultney, Vt.

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Faison, Martha H. (A.M. 1920), teacher of speech correction, Lochland School, Geneva, N. Y.

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Feagin, Frances (A.M. 1936), teacher of speech, Gould Academy, Bethel, Me.

Ferry, Annette (A.M. 1938), kindergarten teacher, Public Schools, Eau Claire, Wis.

Filor, Helen Louise (B.S. 1936), kindergarten teacher, Letchworth Village, Thiells, N. Y.

Finch, Helen Elizabeth, primary teacher, Public Schools, Lake Forest, Ill.

Fisher, Lowell B., superintendent of schools, Mendon, Ill.

Foos, Esther Maud (A.M. 1936), teacher of Braille class, Public School No. 24, Buffalo, N. Y.

Fraser, James Anderson (A.M. 1937), supervisor of student teaching in science and professor of education, State Teachers College, Bemidji, Minn.

Freeman, Thomas E., principal, Bedford Junior High School, Westport, Conn.

Gage, Russell G. (A.M. 1933), head of department of education, Elmira College, Elmira, N. Y.

Gardner, Eleanor Virginia (A.M. 1938),

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Gentilesco, Dominic L., teacher of Spanish, Italian, and French, High School, Mount Vernon, N. Y.

Gibson, Pruella Jane (B.S. 1938), first grade teacher, Ravinia School, Ravinia, Ill.

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Haege, Olive (A.M. 1938), cafeteria manager, American University, Beirut, Syria.

Hagamen, Wilbur D. (A.M. 1933), athletic coach, High School, Batavia, N. Y.

Hancock, Leah A. (A.M. 1937), instructor in home economics education, State Teachers College, Mansfield, Pa.

Hanley, M. Winifred (A.M. 1937), teacher of speech, St. Mary's College, Notre Dame, Ind.

Harnly, Mary, teacher of English and journalism, High School, Junction City, Kan.

Harris, Bessie M. (A.M. 1925), teacher of home economics and director of cafeteria, High School, Middletown, Conn.

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Hewitt, Lucille I., younger girls' secretary, Central Branch, Y.W.C.A., Brooklyn, N. Y.

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Hollis, Ernest Victor (Ph.D. 1938), assistant professor of history and philosophy of education, College of the City of New York, New York City.

Hosford, Gertrude (A.M. 1935), kindergarten critic and instructor in education, Miami University, Oxford, Ohio.

Howard, Laura (A.M. 1934), head of home economics department, Erskine College, Due West, S. C.

Howes, Dorothea (A.M. 1938), teacher of English, High School, Wappinger Falls, N. Y.

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Kruger, Barbara L., dean of women, Susquehanna University, Selinsgrove, Pa.

Kuhlman, Harriette M. (A.M. 1938), teacher of business training and commercial arithmetic, High School, Bristol, Conn.

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Lane, Margaret, children's librarian, State Normal School, Potsdam, N. Y.

Leonard, Eugenie A. (Ph.D. 1930), director of guidance and placement, Public Schools, Portland, Ore.

Linn, Maynard W., superintendent of schools, Greenwich, Conn.

Lombard, Eleanor Henderson (A.M. 1936), instructor in physical education, Central State Teachers College, Mount Pleasant, Mich.

Long, Hazel Lee, nursery school teacher, Nursery School, Oradell, N. J.

Lyon, Grace Elizabeth (B.S. 1938), teacher of girls' physical education, Public Schools, Elmira Heights, N. Y.

Mayo, Frances Leone, teacher of English, High School, Biddeford, Me.

Mays, Flora (A.M. 1937), teacher of home economics, High School, Ocean Grove, N. J.

McCarthy, Frederick A. (B.S. 1936), teacher of industrial arts, High School, Teaneck, N. J.

McCreight, Jean D., second grade teacher, Public Schools, Swarthmore, Pa.

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Miller, Florence Ann (B.S. 1938), nursery school teacher, Bethlehem Day Nursery, New York City.

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O'Neil, Ruth Dimack (A.M. 1937), third grade teacher, Friends School, Baltimore, Md.

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Phillips, Velma (Ph.D. 1930), dean of home economics, State College of Washington, Pullman, Wash.

Pillar, Maybelle A., dean of women, Junior College of Southeastern Colorado, Lamar, Colo.

Plumer, Helen L. (A.M. 1937), teacher of speech and English, High School, Haddon Heights, N. J.

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Rockwood, Vivian, home economics assistant, Keene Normal School, Keene, N. H.

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Rustad, Maxine L., teacher of household arts, Lincoln School, Teachers College, New York City.

Sayers, Laura, teacher of French and English, Blanche Kellogg Institute, Santurce, San Juan, Puerto Rico.

Schropp, Edna Mary (A.M. 1925), dean of girls, Senior High School, Decatur, Ill.

Seaton, James Kirk, editor of *Your Future*, American Education Press, Columbus, Ohio.

Seidle, Charles A. (A.M. 1936), assistant director of admissions, Lehigh University, Bethlehem, Pa.

Senna, Ruth (B.S. 1937), third grade teacher, Public Schools, Winchester, Mass.

Shepard, Natalie (A.M. 1936), assistant professor of physical education, Ohio Wesylan University, Delaware, Ohio.

Shipman, Wanda Rae (A.M. 1938), teacher of elementary arithmetic and reading, Buck Run School, Buck Run, Pa.

Simmons, Lottie (A.M. 1931), instructor in home economics, Sullins College, Bristol, Va.

Sligh, Nora (A.M. 1938), instructor in speech, Cottey College, Nevada, Mo.

Smith, Grace May, house director, Holmquist School, New Hope, Pa.

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Snyder, Harold E. (A.M. 1933), assistant to director, Commission on Teacher Education, American Council on Education, Washington, D. C.

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Southworth, John (A.M. 1936), master of history and social studies, Brunswick School, Greenwich, Conn.

Sparks, Henrietta (A.M. 1938), teacher of health and physical education, Junior and Senior High Schools, Selah, Wash.

Stout, Myron S. (A.M. 1938), teacher of art, Kamehameha School for Boys, Honolulu, T. H.

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Tait, Jean Douglas (B.S. 1927), dietitian and teacher of home economics, Flora Macdonald College, Red Springs, N. C.

Torvick, Agnes, sixth grade teacher, Archer Street School, Freeport, N. Y.

Unzicker, Samuel P., instructor in physical sciences and education, State Teachers College, Paterson, N. J.

Van Nostrand, Charles Edmund (A.M. 1938), teacher of biology and general science, Riverdale Country School, Riverdale-on-Hudson, N. Y.

Warner, Blanche Caroline (B.S. 1938), second grade teacher, Public Schools, Great Neck, N. Y.

Watts, Gardner F., teacher of history, High School, Suffern, N. Y.

Weckwerth, Charles F., director of Men's Division, Y.M.C.A., Providence, R. I.

Wells, Emma (A.M. 1938), director of home economics, Shaw University, Raleigh, N. C.

Westfall, Leon H. (Ph.D. 1934), supervising principal, Public Schools, New Hartford, N. Y.

Wheeler, Alfred George (A.M. 1937), instructor in physical education, Nebraska State Teachers College, Peru, Neb.

White, Mary E. (A.M. 1937), director of physical education for women, Fairmont State Teachers College, Fairmont, W. Va.

Winner, Jean B. (B.S. 1935), second grade teacher, Public Schools, New Canaan, Conn.

Wisniewski, Stella (B.S. 1938), sixth grade teacher, Bedford Elementary School, Westport, Conn.

Wright, Mary H. (A.M. 1927), head of English department, McKendree College, Lebanon, Ill.

Yost, Mary Elizabeth (A.M. 1938), dietitian, Perkiomen Boys Preparatory School, Pennsburg, Pa.

Young, Ida M., instructor in psychology, Asheville Normal and Teachers College, Asheville, N. C.

Zimmerman, Irene (A.M. 1938), teacher of Spanish, Columbia High School, South Orange, N. J.

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